THE

ELECTRICAL REVIEW.

VOL. XXXVII OCTOBER 4, 1895. No. 932.

CONTENTS:

	PAGE
The Extra-Judicial Functions of an Engineer	401
The Variation in the Electrical Resistance of Bismuth, when Cooled to the Temperature of Solid Air *(illustrated)*	403
Block Signalling	404
Reviews:—Polyphase Electric Currents	405
The Electric Telegraph	405
The British Association:—	
The Hermite Process of Deoderising Sewage	406
Some Experiments made with Lord Kelvin's Portable Electrometer	407
Do Vertical (Earth-air) Electrical Currents Exist in the United Kingdom?	407
Probable Projection Lightning Flashes	408
Experiments for Improving the Construction of Practical Standards for Electrical Measurements *(concluded)*	408
The Field Telegraph in the Chitral Campaign *(illustrated)*	409
London County Council and Metropolitan Electric Lighting	412
Correspondence:—Localisation of a Fault by Kennelly's Method	413
Iron Losses in Transformers	414
Compounding Dynamos by Armature Reaction	414
More Chips from a True Workshop	414
A New Battery Element	415
Cylinder Condensation Surfaces	416
Business Notices, &c.	417
Electric Lighting Notes	418
Electric Traction and Motive Power Notes	419
Telegraph and Telephone Notes	419
Contracts Open and Closed	420
Notes	421
City Notes	424
Traffic Receipts	424
Share List of Electrical Companies	425
Gas and Oil Engines	426
An Electric Pressure Sound for the Direct Vibration of the Membrana Tympani *(illustrated)*	427
Electro-deposition of Brass *(illustrated)* *(concluded)*	429
Another Remedy for Electrolytic Corrosion from Street Railways *(illustrated)*	430
New Patents	431
Abstracts of Published Specifications	432

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SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other Countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

THE EXTRA-JUDICIAL FUNCTIONS OF AN ENGINEER.

AT the recent meeting of the Brush Company, a more than ordinarily level-headed shareholder condemned a clause in the agreement with the City Electric Lighting Company, which, in the event of a dispute, made the City Company's engineer the sole arbiter. As a business man, he utterly failed to appreciate the position. We claim no special merit in being wholly in sympathy with him. Absurd clauses generally find their way into agreements for one of two reasons: either the chances of them becoming obligatory are so remote that they are permitted to remain undisturbed, or they are inserted under a mild system of coercion.

Whether clauses imposing such extraordinary quasi-judicial functions are common outside electrical work we do not know, but it is common knowledge that in every important electrical contract, clauses are inserted under which the engineer responsible for the works is constituted sole judge of the quality of all the material and workmanship employed upon the works; usually, also, he is empowered to dismiss any of the contractor's men, foremen or superintendents, without assigning a reason; further, he may stop the work, alter the plans, and put his own interpretation on the clauses of the contract.

Although we have specifically mentioned the case of the Brush Company, we shall not attempt in the slightest degree to enter into the rights and wrongs of the dispute that has ended so disastrously for that company. We are concerned only with the disabilities under which all electrical contractors labour when accepting a contract. Considering the imposition of such ridiculous conditions, it may seem curious that we hear of no general strike of contractors, and of no assassinated engineers. The reason, though not obvious, is simple; it is because, as a rule, the engineer recognises that as soon as the contract is signed he becomes the living and visible representative of the spirit of the contract, and, as such, feels that his moral obligations are as great towards the man who works, as towards the man who pays; in addition to this mental attitude of the engineer, there is the external safeguard due to the fact that a professional reputation is built up mainly on the good opinion of contractors. Hence it arises that Great George Street is not built of glass houses, and has no public washing days; its motto is "Honour bright," and it lives fairly close up to it.

At the same time contractors and engineers view the fulfilment of a contract from entirely different standpoints. It is more than probable that the engineer may have much to object to and much to insist on during the process of contracting; but while a good deal is left to the discretion of the engineer, it is clear that there

is need for distinct limitations to his functions. When great differences of opinion arise between the engineer and the contractor, involving important principles, it is hardly likely that the engineer, in his dual capacity of disputant and judge, can do absolute justice to the contractor. It is true that the engineer ought to know what he wants; but, without any desire to curtail his powers, it is obvious that anything of a controversial nature ought to be settled by an outsider.

If such curtailment of the power of engineers is desirable how much more is it necessary when he is a permanent salaried officer of the company or corporation which employs him; a large proportion of the work done under contract in this country is carried out under men so situated. Happily, Englishmen, and English engineers particularly, are naturally fair-minded or the consequences would be serious, for it is obvious that an engineer in such a position cannot easily forget that his bread has the butter on one side only; he is dependent at all times on the opinion of his employers, and the contractor is as nothing to him. The most remarkable feature of these contracts is that the clauses are often much more stringent than those drawn up by the unattached engineer; for instance, in the specification submitted to the electrical industry last year by the London County Council, unlimited power was given to the engineer, but there was an arbitration clause. It will be scarcely believed that the engineer was appointed sole arbitrator.

In another form of contract which we have seen, the engineer is made sole judge of everything between the two covers. He may decide on any matter in dispute with or without the presence of the contractor, who shall not object to his ruling, even on an allegation of fraud. One wonders what manner of men they are that draw up such clauses. We do not care to think that engineers are responsible, and we can hardly conceive of any sane lawyer perpetrating them, because he of all men ought to know that such clauses would be simply swept aside in a court of law.

There is another important matter arising out of this. From all the principal firms we hear complaints as to the difficulty, nearly amounting to impossibility, of collecting the last balance of retention money on municipal contracts. Great works have been carried out and excellent all round results have been achieved, but there has been no excellent all round profit; in fact, the principal balance-sheets of the year have been disappointing, and we can see no prospect of improvement until contractors generally, absolutely refuse to enter into any contract which is not fair to both sides. The difficulty is that if one firm refuses to take contracts plus absurd clauses, there are others quite ready and willing to take them without question. This renders an adjustment of the matter extremely difficult. An agreement among electrical manufacturers to decline contracts which include onerous conditions is too much to expect, but municipal engineers would be doing an immense service if they would help to secure a mitigation of the more objectionable clauses, and the insertion of a provision for appeal to arbitration on any point that may become a matter of dispute under the specification.

The Pacific Cable.

The *Morning Post* of last Thursday contained a leader dealing with the present position of this scheme. There is a great deal of truth and sound common sense in its criticism of the way in which this great scheme has been managed all through, and unless someone with some business capacities comes to its rescue, things are likely to remain *in statu quo* for some time yet. Not so, however, with the rival schemes, which, based on commercial interests, and managed by business men, are making rapid strides. The obtaining of the concession from Hawaii only the other day was a great step, and if the Government of the United States also grant a subsidy, while our own schemes are still in the air, we shall perhaps find a cable laid to Hawaii to be very soon extended to New Caledonia. Then where will the strategic cable be?

The Telegraph in Chitral.

The paper read before the British Association by Mr. P. V. Luke, on the telegraph in Chitral, graphically portrays the difficulties that the Civil Telegraph Department of India has to face during a campaign. Although Mr. Luke modestly states that the route was not a very difficult one, our illustrations at least show some varieties of country that could be scarcely considered easy for climbing, much less for laying telegraph wires. Considering the extraordinarily rough conditions under which the lines are laid, it is astonishing how well the work is done. Where monsoons are an everyday product of the country, variations of temperature remarkable, avalanches in winter as common as blackberries in autumn, and where the natives find telegraph wire very useful, it needs more than ordinary skill to preserve a moderate continuity of communication. Perhaps one of the most noteworthy features in the march of the telegraph to Chitral was the speed at which it was done, it averaging five miles a day for 37 days, which taken in conjunction with the fact that the line was a permanent one, is no mean performance. The Indian Telegraph Department is rightly held to be one of the most efficient branches of the service in our Eastern possessions.

The Fatality on the Portrush Railway.

In spite of the fact that the Board of Trade enquiry into the cause of the death of a cyclist near Giant's Causeway Electric Railway, ought to be taken most seriously, it is difficult to read the report of the evidence without being amused. The asseverations of the witnesses were of the most conflicting nature. Mr. Porte, an electrical engineer, gave it as his opinion that the voltage usually employed on the line or rail, 290 volts, was dangerous to human life; the killing of cows and heifers provided other witnesses with materials for a few Irish bulls, while others who were subject to rheumatism, bore testimony to the fact that they were in the habit of taking shocks regularly without material result. One witness deposed that he knew a man whose membranous external investment was of such a pachydermatous nature that it was impossible for him to receive a shock. From such witnesses it is not probable that the subject will receive much illumination. It may however be said that though 290 volts is hardly likely to kill a man, it might, under very extreme conditions, have a fatal effect. It would be obviously unfair to say more, however, until the issue of Major Cardew's report.

Some Interruptions and a Moral.

Having regard to the number of electric light works in this country, the interruptions to the continuity of supply are remarkably few. Still, one occasionally hears of breakdowns which, in spite of the exaggerative qualities of the provincial Press, might at any time lead to serious consequences. One or two towns have had serious stoppages of late, which rather inclines one to think that a greater margin of safety may be desirable than is at present allowed. The confidence of the public ought to be maintained, even if it meant a little larger outlay in machinery.

THE VARIATION IN THE ELECTRICAL RESISTANCE OF BISMUTH, WHEN COOLED TO THE TEMPERATURE OF SOLID AIR.*

By JAMES DEWAR, M.A., LL.D., F.R.S., Professor of Chemistry in the Royal Institution, &c., and J. A. FLEMING, M.A., D.Sc., F.R.S., Professor of Electrical Engineering in University College, London.

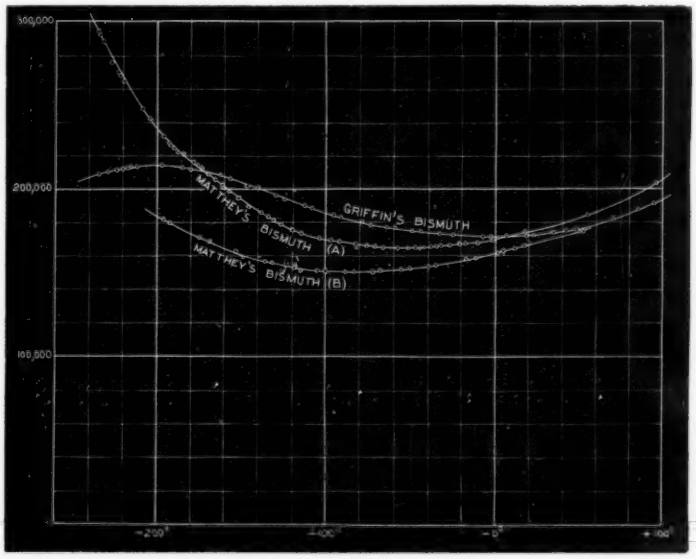
Plate V.

In the course of investigations on the electrical resistance of pure metals and alloys at low temperatures made during the years 1892 and 1893, the results of which were communicated to the *Philosophical Magazine*,† extensive examination was made by us of the variation in specific electrical resistance exhibited by most of the ordinary metals when cooled to temperatures approaching the absolute zero. In the course of this research the abnormal behaviour of bismuth with regard to its variation of specific resistance with temperature, was noted, and in a further research on the thermo-electric powers of metals and alloys at low temperatures, the results of which were communicated to the *Philosophical Magazine* recently,‡ it was noticed that the curves representing the thermo-electric power of bismuth, both for pure and for commercial specimens, presented a discontinuity at temperatures lying between about − 70° and − 100°. We were therefore recently led to make a more careful examination of the variation of electrical resistance of bismuth, when cooled down to the temperature of solid air, some of the results of which are of sufficient interest to communicate, although the investigation is still in progress, and much remains to be done to complete it. A sample of very pure bismuth was kindly prepared for us by Mr. George Matthey, by the reduction of the oxide, an analysis of which showed very small traces of iron as the only impurity. This bismuth, which was the same as that used by us in our thermo-electric experiments, was pressed into wire by a steel press, two sizes of wire being prepared, one having a diameter of about 0·067 centimetre, and the other a diameter of 0·049 centimetre. Lengths of these wires were mounted up in an appropriate form for taking the electrical resistance when measured in liquid or in solid air, or at any other temperature up to + 100° C.

Amongst other specimens a wire was pressed from some commercial bismuth, supposed to be fairly pure, which will be distinguished by being called Griffin's Bismuth; the diameter of this last wire was about ·066 centimetre. The diameters of these wires were carefully measured with a microscope-micrometer in about twenty different places, the lengths of the wires used being about 30 or 60 centimetres. The sample of pure bismuth prepared for us by Mr. George Matthey will be distinguished by speaking of it as Matthey's bismuth, the thicker of the two wires being called A and the thinner B. The dimensions and mean diameters of the pressed wires, which were used just as they came from the press, were as follows:—

Sample.	Length. centim.	Mean diameter. centim.
Matthey's Bismuth (Pure), A ...	61·25	0·06713
Matthey's Bismuth (Pure), B ...	32·70	0·04926
Griffin's Bismuth	52·90	0·06625

In addition to these samples of pressed wires, other specimens were prepared by drawing melted bismuth up into fine glass tubes and making a suitable connection with the bismuth for the purpose of an electrical resistance measurement by means of tinned copper wires melted in to the ends of the bismuth specimen. These samples of bismuth then had their electrical resistance measured with a Wheatstone bridge in the usual way, the temperature of the specimen being taken at the same time by means of a platinum thermometer, consisting of a platinum wire closely in contact with the specimen of bismuth. All the temperatures which are given in the following paragraphs have been converted into platinum temperatures, taken in terms of our standard platinum thermometer P_1, the electrical constants of which were given by us in the paper on the thermo-electric powers of metals (see *Phil. Mag.*, July, 1895). Temperatures so measured are distinguished by the letter P_1 placed after the number denoting the temperature. The electrical resistance of the bismuth specimens, all proper corrections being made for the resistance of the connecting wires, was taken at a large number of temperatures lying between the boiling-point of water (100° C.) down to the temperature of solid air, which, in terms of our standard platinum thermometer P_1 is about − 233° P_1 to − 235° P_1. From the known dimensions of the bismuth wires the volume specific resistance of the metal was calculated at these different temperatures, and the reduced observations for the three specimens above mentioned are given in the following tables.



The above numerical results are set out in the form of three curves (see Plate V.). It will be seen that the specific electrical resistance of all the bismuth specimens taken from 100° C. downwards gradually diminishes to a point which, in the case of the specimen of pure bismuth "A" was about 50° P_1, and in the case of the specimen "B" about − 83° P_1. After these temperatures had been reached, further cooling *increased* instead

* From the *Philosophical Magazine* for September, 1895.

† Dewar and Fleming, *Phil. Mag.*, 1892, 5th series, Vol. xxxiv., p. 326, "On the Electrical Resistance of Pure Metals, Alloys, and Non-metals at the Boiling-point of Oxygen"; also *Phil. Mag.*, 1893, 5th series, Vol. xxxvi., p. 271, "The Electrical Resistance of Metals and Alloys at Temperatures approaching Absolute Zero."

‡ Dewar and Fleming, *Phil. Mag.*, July, 1895. "Thermo-Electric Powers of Metals and Alloys between the Temperatures of the Boiling-point of Water and the Boiling-point of Liquid Air."

of diminishing the electrical resistance of the A and B bismuth, until at the lowest temperature reached by the employment of large quantities of solid air, the electrical resistance of the

Commercial Bismuth (Griffin's).

Volume specific resistance in C.G.S. units.	Temperature in platinum degrees.	Volume specific resistance in C.G.S. units.	Temperature in platinum degrees.
190,700	+95·0	185,050	— 96·9
186,850	+84·6	188,450	—107·9
180,350	+66 6	190,050	—111·7
176,450	+47·0	193,800	—123·5
176,200	+46·5	195,400	—128·1
175,200	+41·2	199,700	—140·0
173,650	+34·0	200,700	—143·9
172,000	+21·3	205,400	—157·0
172,300	+18·8	207,000	—162 0
171,450	+ 5·2	211,450	—180·0
171,050	− 2·2	211,750	—184·0
171,100	− 6·8	212,800	—196 6
171,650	−25·0	212,800	—196 8
172,050	−32·7	212,050	—213·2
173,400	−43·0	212,100	—215·5
173,700	−47·3	211,700	—217·1
176,050	−59·6	211,500	—220·1
176,700	−63·3	210,900	—222·5
179,050	−75·1	209,700	—228·5
180,100	−79·1	208,900	—232·8
184,400	−92 9	208,950	—233·2

Pure Bismuth (A) (Matthey's).

Volume specific resistance n C.G.S. units.	Temperature in platinum degrees.	Volume specific resistance in C.G.S. units.	Temperature in platinum degrees.
202,550	+ 96·4	183,350	− 135·0
185,100	+ 56·0	186,000	− 139·0
174,200	+ 17·8	188,850	− 145·9
171,100	+ 5·2	193,100	− 151·6
169,750	− 1·8	197,450	− 156·6
168,150	− 9·7	200,650	− 160·8
166,900	− 16·9	204,800	− 165·8
166,550	− 20·5	208,250	− 170·5
166,300	− 24·9	211,350	− 173·9
165,850	− 30 0	213,950	− 176·8
165,600	− 33 0	217,100	− 179·8
165,400	− 37·0	220,200	− 183·0
165,050	− 42·5	222,500	− 186·3
164,800	− 45·0	225,300	− 188·9
164,750	− 47 0	228,150	− 192·0
104,750	− 53·0	229,300	− 192·7
164,900	− 58·4	229,850	− 193·3
165,200	− 65·0	234,800	− 197·0
165,850	− 69·3	242,150	− 202·6
166,150	− 74·5	248,150	− 207·9
167,300	− 81·4	264,400	− 219·3
168,600	− 89·1	266,250	− 220·8
169,400	− 95 0	267,900	− 222·0
171,100	− 101·8	276,700	− 227·1
175,150	− 114·0	288,450	− 232·0
176,950	− 120·1	293,100	− 234·2
178,950	− 124·9	294,300	− 234·85
181,150	− 130·4	294,300	− 234·9

Pure Bismuth (B) (Matthey's).

Volume specific resistance in C.G.S. units.	Temperature in platinum degrees.	Volume specific resistance in C.G.S. units.	Temperature in platinum degrees.
175,100	+49·2	150,600	— 87·9
174,850	+48·0	151,300	—100·5
165,100	+18·8	151,300	—103 9
163,050	+11·3	152,000	—114·8
161,550	+ 3 6	152,850	—118·8
161,250	+ 1·3	154,950	—132 2
158,400	—11·5	155,900	—136·1
157,900	—18·3	159,450	—148·1
153,750	—36·5	161,200	—152·2
153,300	- 40·0	166,300	—168·0
152,350	—51·6	169,850	—174·9
152,050	—55·3	179,550	—193·4
151,000	—66·8	181,000	—196·2
150,850	—71·0	181,000	—198·8
150,500	—83·3	...	...

specimen "A" had become increased by nearly 80 per cent. of its minimum resistance, and at the same time the mean temperature coefficient had become very large, and of course negative. It may be noted that the melting point of solid air, as determined by our standard platinum thermometer, is − 232°·2 P_1, liquefaction taking place under a pressure of 14 millim. of mercury. The boiling point of liquid air under a pressure of 746 millim. is − 209°·75 P_1. The same general facts were observed in the case of the specimen of pure bismuth "B," only in this instance the temperature was not taken below about − 200° P_1. As regards the commercial bismuth (Griffin's) the curves show that after reaching a minimum point, which for that specimen appears to occur at about 0° C., there is another point of inflexion in the resistance curve in the neigbourhood of − 200° P_1, after which the resistance again diminishes. In the case of each of these specimens the resistance measurements were repeated many times, and in both directions, to obtain an assurance that the relation of resistance and temperature was perfectly definite, and that proof might be obtained that all the three specimens of pressed bismuth wire as well as the bismuth melted in the tubes, did not undergo any permanent change in their condition by the action of the low temperature, but that there was a definite relation between temperature and electrical resistance in the manner shown in the curves.

(*To be continued.*)

BLOCK SIGNALLING.

It is with pleasure we notice in the columns of our contemporary, the *Railway Engineer*, a letter from Mr. A. H. Johnson, late consulting engineer to the Johnson & Hall Signal Company of the United States of America, directing attention to the need of interlocking the electric with the mechanical signals. We have from time to time pointed out, not merely the need of this, but the absolute inconsistency which now attends the method by which our railway traffic is controlled. Means of combining the two systems have been before the public and the several railway companies, and have been brought under the notice of the Board of Trade for years, and to some extent has been employed, but only in a very limited degree. That it is better to work the two independently than to dispense entirely with the electric, we readily accord, but having regard to the fact that the employment of the electric block signalling system has been, of late years, rendered compulsory, every railway is now equipped with it, and it only remains to associate it in such a manner, with the mechanical signals—those which govern the engine-driver—as to render it impossible to operate the latter without the consent of the former.

Mr. Johnson points out that in the United States a practice prevails of employing in the rails specially insulated joints "which are strong enough to bear the strain of the 120 ton locomotives," by which means the line is divided into sections. The arrangements of the electrical apparatus is such that during the time no train is passing over the section, the current admits of the operation of the signals, but immediately a train, or a pair of wheels, enters upon the section of rails, the electrical apparatus is short-circuited and the signals become locked.

The principle is a well-known one, and we are under the impression that it has more than once been placed to the test, and that the result has not been encouraging. Whether, however, this is due to climatic influences, want of co-operation or confidence on the part of the permanent-way authorities, or to the numerous points and crossings—which, of course would, if not insulated, form a constant short circuit—we are not in a position to determine. The system, if applicable to the conditions which attach to our railway service, is simple enough, and would, if adopted, prove unquestionably a step in advance of the present general mode of working our block signals; but the question which presents itself to our mind most forcibly is whether it, anymore than that which has so far been done, meets what is required. The system so far employed by our own railways is not complete, and does not cover every contingency. It is the first vehicle which operates the treadle, and so controls the interlocking. A portion of the train may be left behind, yet the automatic clearance of the section would be accomplished. This is not good. The system advocated by Mr. Johnson

provides against this, for, so long as a pair of wheels having electrical connection between them remains upon the metals, the interlocking is in force—but it is clear considerable difficulty would arise in yards where crossings were numerous, and here it is doubtful if the system is applicable. Obviously it is desirable something should be done. The system under which block signalling is now conducted cannot be regarded as satisfactory. It is imperative for reliable working that the electric signals should be interwoven with the mechanical signals, so that the former may have a proper control of the latter, but the means of effecting this must be such as will afford perfect protection, and not leave a loophole for further mischief. Whatever the system employed may be, it should be such that there shall be no possibility of a portion of a train being left behind without the signals remaining locked.

REVIEWS.

Polyphase Electric Currents. By S. P. Thompson, D.Sc., F.R.S. London: E. & F. N. Spon.

This is a treatise for which there has long been a demand. As far as it goes it is a useful work, but it does not go far enough. The chapters on the practical side of the subject are almost wholly confined to descriptions, explanations, and designs of polyphase motors of German-Swiss origin. A good deal of matter is devoted to historical points, some of which are erroneous in chronology. The two-phase inductor-alternator, in which iron only forms the moving part, is attributed to Mr. Wm. Stanley, of Pittsfield, whereas it was first designed and patented by Mr. Rankin Kennedy in 1890, nearly two years prior to Stanley's patent. Then on the points of difference between the widely divergent types of induction motors, the author is not at all explicit. The student would have obtained a much clearer insight into the actions involved had the three types of induction motors been minutely dissected and contrasted; the Œrlikon and Brown motors only are detailed.

The author is a believer in the "rotary polar" theory, and throughout the work this idea is the governing one. This preaching of the gospel of rotating polarity is, we think, an unfortunate mistake. There is no need to take up the rotary polar theory to explain the action of polyphase motors, as their action can be better explained by the ordinary theory of electromotors.

Rotary poles serve to distinguish the Tesla type of motor, and distinguish equally the two and three-phase rotary polar motors. Any motor in which the poles rotate or shift comes under Tesla's claims.

A type of induction motor is alluded to which was first proposed by Atkinson in 1888, and the author goes on to state that a Stanley-Kelly motor, made in America, differs radically from all others. As a matter of fact, it is essentially the same as that proposed by Atkinson, each "rotor" acting alternately as a transformer. Zipernowski's motor, built on the same principles, and Rankin Kennedy's rotary transformer motor are not mentioned, although both of them are prior to the Stanley-Kelly inventions.

It is stated that there are several methods for obtaining polyphase currents from a single phase current, and a paragraph on page 182 purports to describe a method; but the heading of this paragraph must be a mistake, for it describes only a method of converting two-phase into three-phase, or *vice versâ*, a comparatively easy process. The fact is that single phase may be split into two-phase by an inductive resistance and a capacity; but this method is only useful for temporary purposes, such as starting a motor. There is no really practicable method for splitting single phase into polyphase satisfactorily.

As this book may be taken as the commencement of scientific book literature on the subject, it is a pity that the designs of one or two engineers should receive so much attention, to the complete exclusion of others. The hole winding of "stators" is no doubt the best winding for these particular motors, but it has many drawbacks not referred to by the author, and is only useful in rotary pole motors, while in induction motors, with no rotary poles, it is worse than useless.

Induction motors ought to be classed—1st, rotary polar motors; 2nd, transformer motors; 3rd, single-phase motors. The patents of Tesla cover the first, Kennedy's patents the second, and Brown's patents the third, of these classes.

Although it does not treat the subject exhaustively, the work is very interesting, and the rotary polar motor is very fully illustrated and described, so that to those desiring an acquaintance with this type of induction motor the book will be of great value; two excellent plates of scale drawings of Brown's rotary polar motors are attached, and are of great use in forming an estimate as to dimensions. Another useful feature is the lists and dates of patents and articles relating to the subject.

The Electric Telegraph. Translated from the French of A. L. Ternant by R. Routledge, B.Sc., F.C.S. London: George Routledge & Sons, Limited, Broadway, Ludgate Hill.

The letters "B.Sc." are usually supposed to indicate that the individual to whose name the same are appended is a man of scientific attainments. We have, alas, been so often ourselves deceived in this matter, that we have now very grave doubts whether the honour? is not really a useful indication of ignorance of matters practical, whatever indication it may be of matters theoretical. We have no personal knowledge of the translator of M. Ternant's work; but whatever his merits may be, we can only say that he has shown himself lamentably incompetent to carry out the task he has undertaken. As regards the translation itself, it is doubtless a more or less faithful word for word rendering of the original, such as could be done by almost any penny-a-liner with a knowledge of French; but as a translation which should truly represent the correct meaning of the various technical words and terms met with, it is a terrible production. To take an example or two to commence with, what are we to think of a translation which states that the wires of submarine cables are preserved from rust by two inverse layers of *tow*, mixed with silicated bitumen, or that submarine cables, when they are connected with subterranean lines, are protected by lightning *rods!* Again, page 270, we have the expression (relating to faults in cables) "solution of continuity," the meaning of which, to most people, would be absolutely unintelligible. So faithfully has the original been followed, that the author has not taken the trouble to translate the wording on some of the blocks, but leaves them in the original French.

Mr. Routledge's great mistake has been in not submitting his translation to someone who has had practical experience in telegraphic matters. Whatever may be the translator's ability as regards theoretical science (and we do not venture to doubt this), without practical experience, he must necessarily fail in practical work.

Our attention was drawn to the publication as it lay open on a book-stall, by an alarming picture of the *Great Eastern*, with a terrible list to starboard and rapidly sinking by the head, presumably from the weight of an imaginary cable hanging from her bow. Just as some people, when their New Year copy of the Blue Book arrives, instinctively turn up their own names and addresses, so we turned to the part of this book devoted to the making and laying of submarine cables as being a subject with which we are particularly familiar. The very first sentence is as follows:—"At least half-a-dozen cables cross the Atlantic Ocean, and even the Pacific has now been traversed." This did not seen to be at all the right thing, but we ventured to read fearlessly on all through the 50 pages which are devoted to the subject.

They are apparently written by a Frenchman, who may have seen a submarine cable, and translated by an Englishman who certainly has not, and who, as we have indicated, is utterly ignorant of any of the technical terms in common use on telegraph steamers or any other vessels. The bow sheave is called the "fore pulley," the stern "the behind!" the bow the "front part." The outside yarns of a cable are called (as we have stated) *tow*. A grapnel is described as a "strong iron with three or four arms, weighing 30 or 40 lbs." The operation of grappling is explained as follows, on page 183:—"A dynamometer, under which the line runs, shows the strain, and as soon as a greater strain than that

due to the grapple (*sic*) is observed, it is known that the cable is caught. If it is concluded that the cable has been met with, the ship steams forward against the flow of the tide. As soon as the grapple line is tightened the part overboard is hauled in, until it becomes stretched and upright. The machine is then driven more slowly so as to act only against the current due to the tide. . . . . When the cable is large and tight, great care is required in cutting it. . . . . Picked up cable when brought on board is gradually wound up in a tank."

The crinoline of a tank is described (p. 160) as "a series of concentric circles connected by 10 or 12 radii, which compel the cable to arrange itself in regular layers when it is stowed in the tank. From this the cable is conducted by large cast-iron pipes to the paying-out machine. In its course the cable passes through wooden troughs in order to prevent the heat of the sun from melting the gutta-percha." And so on all through.

But absurdities are not confined to cable matters, there is not a section which does not contain several mistakes. The pages devoted to pneumatic telegraphy contain descriptions of apparatus which has years ago been consigned to the scrap-heap. The signalling instruments are stated to be liable to derangement from the wires coming in contact; as the wires used are all underground, it is difficult to see how a fault of this nature could possibly occur. The "britannia" joint for overhead wires, which is universally used in England, is stated to "present some practical difficulties as regards soldering;" these difficulties exist in the author's imagination only. The use of creosoted poles is said to have been abandoned, as "creosote destroys the workmen's clothes, and takes the skin off their hands and faces." As a matter of fact, there is no other kind used in this country. The maximum speed of the Wheatstone transmitter is stated to be 130 words. Experiments on the duplexing of submarine cables are said to have been carried out by "Mr. Herbert" (the printer, we presume, was responsible for "Taylor" being dropped out). We might go on indefinitely pointing out the errors which may be found in the pages; it is hardly an exaggeration to say that nearly every page contains some ridiculous statement. And this is a volume of Routledge's Popular Science Library. Whether the author or the translator is chiefly to blame we don't know (as we have not the French original before us), we should like to see them fight it out between them; but there can be no excuse for the publication in England of such matter. There are lots of first-rate books on the subject, and if these are not to Messrs. Routledge's liking, there are plenty of men capable of writing others. Translating from French into English, matter which was English long before it was French, is a ridiculous way of going to work even if it is well done.

The only interesting fact which we have come across in the book is an illustrated description of an armour for cables invented by Brett in 1845, which appears to be similar to, and perhaps superior to, that proposed by a correspondent of the Electrical Review on February 12th, 1892, and also to that proposed by Mr. H. Gray, and described in Benest's paper on "Coast Telegraph Communication," read before the Institution of Electrical Engineers, March 18th, 1892. It is certainly curious that two persons should have independently re-invented Brett's idea of nearly 50 years ago. We do not recollect having ever before seen the thing mentioned, and cannot find any record of it at the Patent Office.

In all seriousness, we trust that Messrs. Routledge have printed but a very limited number of the book.

THE BRITISH ASSOCIATION.

THE HERMITE PROCESS OF DEODORISING SEWAGE.

By Mr. J. Napier, F.C.S., F.J.C., &c., Borough and County Analyst.

(*Read before Section G, September 14th*, 1895.

The treatment of sewage for the purpose of preventing putrification is a subject which has occupied the minds of chemical and sanitary engineers for many years, and numerous methods of dealing with it have been devised and brought before this and other societies, each claiming to perform its work in a more perfect manner than its predecessor. Those methods, with only one or two exceptions, treat the sewage at a point between the last inlet into the main sewer and the outfall, usually at the outfall, and as far away from the town as it is possible to put it. Those systems of dealing with sewage at the outfall do not give the town from whence it came any sanitary benefit. They do not prevent sewer gas accumulating in the sewers and escaping into the air from man-holes or ventilating shafts, and becoming an annoyance and nuisance to the inhabitants. The objects of those systems of treating sewage, then, is to purify the sewage sufficiently to prevent the pollution of a waterway or river, and without in any way being of the slightest benefit to the health of the town. With the Hermite process the sewage is treated at the other end of the sewers, *i.e.*, at the beginning, is deodorised there, so that flowing through a town the sewers give off no offensive smells, and the putrefactive changes which take place in sewage have been arrested. With this system, then, there is no need for ventilating shafts, and if the manholes are perforated there is no offensive smell given off; on the contrary, there is a faint chlorous or bleach smell which is much more acceptable to the nose than sewer gas. The principle of this process is passing a current of electricity through sea-water, or, if sea-water is not handy, a solution of magnesium and sodium chlorides, a portion of these chlorides is converted into hypochlorite, a substance which disinfects, deodorises, and bleaches similar to the active ingredient of bleaching powder—calcium hypochlorite. The change from chloride to hypochlorite takes place almost entirely with the magnesium salt-yielding magnesium hypochlorite, $Mg\,Cl_2\,O_2$. It is found, however, that in the electrolysers and tanks a white deposit takes place, consisting of magnesium oxide combined with water, viz., magnesium hydrate, showing that the magnesium hypochlorite has decomposed, forming magnesic hydrate, which precipitates, leaving hypochlorous acid in solution. The action may take place as follows:—$Mg\,Cl_2\,O_2 + 2\,H_2\,O = Mg\,H_2\,O_2 + 2\,H\,Cl\,O$. This is called the Hermite solution. The amount of oxidising power is expressed by the quantity of available chlorine in grammes per litre—the usual working strengths being from 5 to 1 gramme per litre of solution. When sewage is mixed with about 5 per cent. of the gum solution, the offensive smell is instantaneously destroyed, and the decomposition arrested for about six days, long enough under ordinary circumstances for the sewage to be well out to sea. I have not attempted to give a description of the electrolysers and their working; it would only be taking up valuable time. Those who are interested, and will visit the installation in Constantine Road, will see the plant at work, and have all details explained. This electrolysed or Hermite solution has been subjected to many experiments, and numerous criticisms have been made upon it as to its power of rendering sewage sterile—as, for instance, the Lancet Commission, which reports favourably on the system from experiments made at Worthing; also by Sir Henry Roscoe and Mr. J. Lunt, B.Sc., the results of which were read before the Society of Chemical Industry, and described in that Society's Journal in March last. Sir Henry found that a ·8 gramme solution practically sterilised the liquid portion of sewage, when used in sufficient quantity, and that the solid matters were unaffected. Well, a solution which will thus practically sterilise liquid sewage must, I think, be of great value, and when used in effective quantity, tend to benefit this locality by preventing those contagious diseases which are usually developed from sewer gases. Although chemical and sanitary engineers have had this aim, *i.e.*, to completely sterilise sewage, in view, this point has not been attained on the large scale by any of the at present known systems. Hermite solution, however, does the next best thing, for in larger proportions it sterilises the liquid portion, and even in small quantities completely deodorises. This is confirmed by Sir Henry's eleventh conclusion, viz., "The Hermite fluid, even of ·25 strength, acts as an excellent deodoriser." This is the point taken up by the Ipswich Corporation. They say, if we can have the sewage deodorised, and its decomposition arrested for from three to six days, the sewage will be well out to sea, and the nuisances of offensive smells in the towns will be entirely done away with. Sir Henry also made experiments as to the stability of the electrolysed solution, and he found that a ·5 gramme solution lost 90 per cent. of its strength in 24 hours, a ·75 gramme solution being more stable, losing 34 per cent., and a 1 gramme solution 10 per cent. in the same time. This is very interesting and important; but as regards the working of the system in Ipswich, it is not necessary to take this into consideration, because the moment the electrolysed solution is made it is carried direct into the sewer within two minutes after its production. We have in Ipswich been electrolysing sea-water for three months and treating the sewage. The Sewage Committee directed me to report on its working, so I made daily tests and inspections for about two months. The strength of solution varied from ½ gramme to 1 gramme, according to the flow of sea-water through the electrolysers, the quantity of available chlorine made being fairly constant, and the average being 1·04 gramme per ampère-hour. As to the effects of this solution on the sewage, I have no figures to give you, but can give a general idea of its deodorising powers. I shall first draw your attention to a plan of the town of Ipswich, its situation with regard to the rivers and the course of the sewage to the outfall. We have two rivers, viz, the Gipping, a canal which extends and is navigable as far as Stowmarket, about 10 miles inland. The last, or bottom lock, is situated near Handford Bridge. Below this point the river is tidal, and is called the Orwell, which for beauty at high water is not to be excelled even by the Clyde or Rhine. In close proximity to the town we have the dock, covering about 33 acres, along each side of which the principal merchants of the town have their works or premises for shipment. The Gipping has an arm which leads from the locks to where there was once an oil-mill (now the Steam Laundry) driven by a water-wheel, and from this there was a waterway through the town as far as Fison's Mills at Stoke Bridge. When Ipswich was sewered, about 16 or 17 years ago,

according to the suggestions of Mr. P. Bruff, and carried out by our present borough surveyor (Mr. E. Buckham), the main or intercepting sewer was laid in this waterway, from Portman Road, as far as it went, and continues to the outfall. The difficulties in the way of sewering and treating sewage in Ipswich may be explained in Mr. Buckham's own words:—"To dispose of the sewage of Ipswich, either by irrigation or by intermittent filtration, would be attended with considerable expense. The town is divided by the river Orwell, and, as is frequently the case with towns so situated, the longitudinal falls are very slight, while the lateral falls are very great. The fall from the one end of the sewer to the other is only about 8 feet, so that the flow is not very rapid, whilst, taking a section of the town laterally, there is plenty of fall, and, in consequence, a rapid current into the main sewer. On this account the experiments with the electrolysed solution were made on the main sewer, and at present the solution is running in the sewer at Handford Road in close proximity to the beginning of the main sewer. The result is complete deodorisation of the sewage throughout a long length of the sewer. For a distance of 700 yards free chlorine can be instantly detected by test papers, and for a distance of a mile the chlorous smell is perceptible, although insufficient to have any action on the test paper. Not only does the main sewer receive the arterials, but it receives the drainage of several slaughter houses and breweries, containing much organic matter. Below the point indicated (Church Street, St. Clement's) there is such a great increase in the quantity of sewage that the results were doubtful. On several occasions, however, samples taken from the outfall were without smell and kept two days, and in one instance it kept four days. If the amount of electrolysed solution, or its strength, could have been increased, the sewage at the outfall would certainly have been completely deodorised, if not sterilised. This is a point which I hope the Sewage Committee will aim at, and when putting the plant permanently into the new buildings, that they will have sufficient electrolysers and power to produce enough fluid to deodorise all the sewage of Ipswich and have some to spare for flushing or washing infected areas. I noticed in some of my early morning inspections, when the flow of sewage was at its minimum, that the deposit in the sewer was bleached nearly white by the action of the electrolysed solution. This process has not been going long enough to allow me to obtain any statistics as to the health of the borough or the death rate, compared with previous years and with other towns; but this I am sure of, that where the sewage has been treated no complaints have been received as to offensive smells. I am confident that any town that adopts this process, which will boldly erect plant to produce more than enough of the electrolysed solution, will be spending money well, and in time will feel the benefit by increased health of the inhabitants, and also by having a lower death rate. This is what I have suggested Ipswich should do, so that in a year or two, when we are able to make comparisons, we will find a reduction in the death rate. This result will make the process cheap at any price.

SOME EXPERIMENTS MADE WITH LORD KELVIN'S PORTABLE ELECTROMETER.

By Arthur Schuster, F.R.S.

(*Abstract of paper read before Section A.*)

Experiments made during a recent journey to Switzerland have shown to the author how easily observations on atmospheric electricity are performed by means of Lord Kelvin's portable electrometer. The instrument is easily carried in a knapsack to almost any place within reach of the mountaineer, and the observations are readily made in a short space of time in the way long ago described by Lord Kelvin. The object of the experiments was to learn, if possible, whether the electric force at great heights is sensibly different from that at the sea-level. But owing to the difficulty of comparing together observations made in valleys with those made on mountain peaks, the measurements made during the past month were entirely of a tentative character more for the purpose of gaining experience with the instrument and to obtain guidance for future work than with a view of bringing home definite results. The numbers which are given in this brief account have only a relative value, as they are referred to an arbitrary unit. A number of experiments made in fine weather in the centre of a small meadow in front of the hotel at Pontresina gave, on the average, about 30 for the electric force, which is smaller than that found in England under similar circumstances. Thus, on September 13th, at Ipswich, on a plot of grass rather more sheltered by surrounding meadows than the Pontresina meadow, the author found the electric force to be over 80. On the so-called Diarlezza Pass the number found was as high as 147, while on the Isola Pirs, a rocky island, projecting well out of the surrounding glacier, it was 116. On August 19th, the instrument was taken to the top of the Glushaint (12,000 feet), which consists of a ridge of rocks just wide enough for one man to stand upon. The electric force reached the number 816, while on a snowfield a few hundred feet below the top the force was only 170. The top of the Schafberg gave 357 for the electric force. On the Morteraheb glacier the numbers were, as a rule, very low, except on one occasion when a strong downward wind was blowing, but even then the force only went up to 42. Half-a-mile below the snout of the glaciers the numbers found were very irregular, and seemed to depend on the direction of the wind. On one occasion, when the wind was frequently changing, being sometimes up and sometimes down the valley, a negative electrification was observed whenever the current of air was from the glacier. This was probably due to negative electrification caused by the glacier stream, in a way similar to that in which a similar electrification is produced by waterfalls.

The daily variation was observed on one day by taking observations every half-hour from nine to twelve o'clock and every hour in the afternoon until seven o'clock. A principal maximum of 36 was observed at 11 a.m. The numbers then fell irregularly till four o'clock, when the electrification was only 14. After that time it rose to 31 at 5 p.m., and 29 at 6 p.m., and fell to zero at 7 p.m. The wind which had been blowing up the valley all day, changed in direction between the two last observations, and was blowing downwards at seven o'clock. The author does not draw any conclusions from his observations, but does not believe that a mere difference in the configuration of the ground is sufficient to account for the great differences in electric force observed.

DO VERTICAL (EARTH-AIR) ELECTRICAL CURRENTS EXIST IN THE UNITED KINGDOM?

By A. W. Rucker, F.R.S.

(*Read before Section A, September 17th*, 1895.)

In a paper by Dr. Adolph Schmidt read before Section A of the British Association at Oxford,* the author stated that he had expanded the components of the earth's magnetic force in series, and had deduced expressions, two of which give the magnetic potential on the surface of the earth in so far as it depends on (1) internal and (2) external forces. "The third series represents that part of the magnetic forces which cannot be expressed in terms of a potential, but must be due to electric currents traversing the earth's surface." The author concludes that such currents amount "on the average to about 0·1 ampère per square kilometre."

It appears, therefore, desirable that this conclusion, drawn from the magnetic state of the earth as a whole, should be tested by means of those portions which have been most fully studied.

The test to be applied is whether the line integral of the magnetic force taken round a re-entrant circuit is or is not a vanishing quantity.

The irregular form of the United Kingdom makes the application of this test more difficult than it would otherwise be, but as two detailed surveys of Great Britain and Ireland have been carried out by Dr. Thorpe and myself for the epochs 1886 and 1891 respectively, the data at our disposal are so numerous that I thought it worth while to undertake the inquiry. The actual work of calculation has been carried out almost entirely by two of my students, Messrs. Kay and Whalley. My best thanks are due to them for the care and skill they have displayed.

Two circuits called the α and β circuits respectively were selected, bounded by the following lines:—

(α) Long. 2° W., Lat. 58° N.; Long. 7° W., Lat. 52° N.
(β) Long. 1° W., Lat. 55° N.; Long. 9° W., Lat. 52° N.

The work done by a unit magnetic pole on traversing these circuits was calculated for the epoch 1886·0 by means of the terrestrial lines found for that date, and also for the epoch 1891·0 by means (1) of the same lines when due allowance was made for the secular change, and (2) of the independent set of lines found by aid of the later survey.

The magnitudes of the hypothetical currents deduced from these calculations were very small, and those for the later epoch were of opposite signs, according as they were calculated from the earlier or the later survey.

The same calculation was made for two other circuits, one (γ) in Great Britain and one (δ) in Ireland; but instead of using the calculated terrestrial lines, the true values of the forces and declinations were employed, as deduced from the nearest stations. The great local disturbances in Antrim interfered with the value of the Irish circuit. The following table gives the results in ampères per square kilometre obtained from circuits α and β by the terrestrial lines for 1886·0, and also by the mean terrestrial lines for 1891·0, which occupy the mean position between those given by the two independent surveys, and also for circuit (γ).

Circuit.

	α	β	γ
1886·0	− 0·026	− 0·004	...
1891·0	+ 0·001	− 0·005	...
1891·0	...	...	− 0·008

From these we may conclude that there is not in the United Kingdom a vertical current amounting on the average to 0·1 ampère per square kilometre. There may possibly be a current of about a tenth or a twentieth of that amount, and if so the signs show that it probably flows from air to earth, but on account both of the smallness of the results and of the discrepancy between the values obtained for 1891 by two independent calculations, we cannot assert that such a current actually exists.

The calculations do not disprove Dr. Schmidt's hypothesis, as we cannot argue from the condition of a small portion of the earth's surface to that of the whole. The most that can be said is that no evidence in favour of the existence of vertical currents can be drawn from one district which has been very minutely surveyed.

* Report, Brit. Assoc., 1894, p. 570.

PROBABLE PROJECTION LIGHTNING FLASHES.

By Mr. Eric Stuart Bruce, M.A., Oxon, F.R.Met.S.

(Read before Section A, September 14th.)

The revelations of the self-taken photographs of lightning flashes have of recent years caused us to modify our ideas concerning the appearance of lightning, and the varied forms displayed foretell that a future classification will be no easy task. The object of the present paper is to suggest the possibility of a kind of flash, which may be called a projection flash, the existence of which would by no means tend to make the work of classifying simpler. When we view the effects of a distant thunderstorm over a large area, such as the surface of the sea, sometimes a bank of clouds, sometimes the whole horizon, appears lit up with a sheet of light. This species of lightning we call sheet lightning, and we may compare this effect to my flashing this incandescent electric lamp so that its flashes are reflected by this white screen. Though on the reflecting surface of clouds we can see no form of flash, yet we know that the sheet of light is made up of countless images of the lightning flash, superimposed one upon the other, so that we cannot distinguish them. So, also, when we flash this incandescent lamp, we know that the light reflected from the screen is made up of a number of images of the white hot carbon filament of the incandescent electric lamp. This is seen to be the case when I limit the space through which the rays of light pass from the incandescent carbon to a small orifice in an otherwise opaque screen. Then there appears an inverted image of the white hot horseshoe of carbon on the screen. We call it the projection of the image of the incandescent carbon filament. It seems obvious that in Nature there must often be an obstruction between the lightning flash and the reflecting clouds in the form of a cloud that has a small opening in it. This condition of cloud perforation is frequently seen. On the screen I throw a rough sketch of a cloud with four perforations, as seen from my balcony on Campden Hill, June 14th, 1893. When there is a cloud with a sufficiently small opening in it between the flash and reflecting clouds, the latter being in an adequate position, on the clouds which otherwise would have been merely illuminated by sheet lightning, there will appear the optical projection of a lightning flash. When the projection of an incandescent lamp falls on a level surface, we obtain a perfect image of the white hot filament; when, however, I cause the screen to become suddenly irregular, we obtain a distorted image of the filament on the uneven surface, and so in nature, if the surface of clouds upon which the projection of lightning flash falls is quite even, we shall have a perfect reproduction of the lightning flash, save that it is inverted, and to some extent dulled in brilliancy. If, however, as would often be the case, the surface of the clouds is irregular, the projection of the flash will take the shape of the irregular surface, and there will be presented a flash very different from the original on the screen. I show a photograph of that type of flash which is called "streaming" in the report of the Thunderstorm Committee of the Royal Meteorological Society, drawn up by Mr. Abercromby (*Quarterly Journal*, July, 1888). To quote Mr. Abercromby's words, "It is a plain, broad, rather than smooth streak of light." I will now project this flash on some model clouds of the cumulus type, and you see its appearance is altered, being no longer the smooth streak of light, but what might be called a zigzag flash with long angles. It is something rather like what has been often represented by painters in pictures where lightning appears, which leads one to think they may sometimes have taken projection flashes as their models, perhaps because this form of flash would not dazzle the eye as do the real discharges. It must, however, be borne in mind that Turner, in his storms, generally painted lightning flashes very like those registered on the photographic plate. In Turner's "Bars Rock," the lightning flash closely resembles some of the photographs. It should also be mentioned that Mr. Ruskin, in *Modern Painters*, when criticising Turner's "Stonehenge," describes the lightning in that picture as "The white lightning, not as it is drawn by less observant or less capable painters in zigzag fortifications, but in its own dreadful irregular line of streaming fire." I have, however, nearly come across a print of Turner's "Lake of Thun," in which there is a lightning flash with at least one decidedly long angle. When travelling in Switzerland about three years ago, the train was passing through a valley while a severe thunderstorm was in progress. The valley was filled with wreaths of mist forming an uneven surface. Suddenly there appeared in the mist a long zig-zagged flash of lightning, seemingly quite close to the window of my carriage. It was not of that overwhelming brilliancy that would have been expected of it if it had been the electric discharge itself at such very near quarters, but was lulled in brilliancy so that I could see the form without my eyes being in the least dazzled, and I felt very inclined to think this was a projection flash. If projection flashes occur in nature as often as I am led to think is the case, it becomes a question whether the photographic plate can register the projection flash. If it does, we may be somewhat misled in our description of the form of the lightning flashes depicted on the plate, some being perhaps not the original, but its distortion. There is one more point concerning the projection flash which seems worthy of notice. If there are more openings than one in the cloud through which the rays of light pass from the flash, there will necessarily be a reduplication of the flashes, giving a multiple effect. To represent a light flash I now have a piece of platinum wire made white hot by the electric current. Between this and the screen I place a sheet of cardboard. I now make one hole in the cardboard, and there is one image of the lightning flash on the screen; I make a second, and there is another image; and as I continue to perforate the cardboard, I get a corresponding number of images. Perhaps those multiple effects we so often see might be sometimes caused by there being several openings in the cloud between the flash and the surface.

The lantern illustrations were by Mr. W. Vick.

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

(Submitted to Section A, September 18th, 1895.)

Report of the Committee, consisting of Prof. Carey Foster (Chairman), Lord Kelvin, Profs. Ayrton, J. Perry, W. G. Adams and Lord Rayleigh, Drs. O. J. Lodge, John Hopkinson and A. Muirhead, Messrs. W. H. Preece and Herbert Taylor, Prof. J. D. Everett, Prof. A. Schuster, Dr. J. A. Fleming, Profs. G. F. FitzGerald, G. Chrystal and J. J. Thomson, Messrs. R. T. Glazebrook (Secretary) and W. N. Shaw, Rev. T. C. Fitzpatrick, Dr. J. T. Bottomley, Prof. J. Viriamu Jones, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. G. Forbes, and Mr. Rennie.

(Concluded from page 381.)

APPENDIX.

It need hardly be said that in the last resort it rests with practical men to employ or decline any suggested system of units. Those who daily deal with the quantities under consideration are the best judges of the utility or otherwise of a suggested unit, provided always that they take the trouble to give it a fair trial, and see how it works in practice. It may be hoped that the above, or similar suggestions, will meet with criticism at the hands of such men, and in order to make a beginning of criticism, I asked the Departmental Lecturer on Electrotechnics at University College, Liverpool (Mr. F. G. Baily), to consider them with special reference to:—

1. The large size of the weber and henry units;
2. The handiest definition of the gauss; and
3. The least troublesome mode of bringing in the 4π.

His reply, which is annexed, covers these points, and also incidentally refers to the quantity called I, or intensity of magnetisation.

Now, as must often have been pointed out, the equation $B = H + 4\pi I$ is a barbarous one, involving as it does quantities of different dimensions in one equation. Its true meaning is, of course, $B = \mu_0 H + (\mu - \mu_0) H$; which, although algebraically only a roundabout method of writing $B = \mu H$, is yet convenient, as exhibiting separately the part of the induction due to the ether, and the part due to a material medium.

The customary convention of further denoting $(\mu - \mu_0)/\mu_0$ by the symbol $4\pi\kappa$, and then christening κH as the magnetisation I, is likewise convenient. With this definition κ is a pure number, and I is a gauss gradient or field intensity. Another, but, on the whole, less satisfactory definition, viz., the omission of μ_0 from the denominator, would make κ of the same dimension as μ, and I an induction density.

The pull between two parallel magnetised surfaces of area A is $\frac{1}{2} A B H \div 4\pi$, that is to say, $N H/8\pi$, and is therefore measured in webers multiplied by the gauss gradient, or in joules per centimetre. But to maintain an induction density, B, in air requires a gauss gradient B/μ_0, hence we might write the pull across an air gap as $N^2 \div 8\pi\mu_0 A$. If the induction density across an air gap is expressed in microwebers per square centimetre, the tension there comes out in units of which 2,500 would make an atmosphere; or, roughly, in pounds per square foot.

As for the strength of a magnetic pole—a quantity which, though fundamental in one sense, is seldom really dealt with—it will naturally be expressed in ergs per gauss, or in joules per gauss, if it is very strong.

Mr. Baily's chief practical suggestions are, first, that a special unit of permeance, other than the henry, is desirable; and, next, that the $4\pi/10$ had best be thrown on to the μ, so as to keep the gauss equal to 1 ampère turn. The fact that the inductivity of air will then cease to appear in its artificial garb of unity may even be regarded as a positive advantage, because its existence will then be less likely to be ignored. But I much fear that the ampère turn as unit of gaussage, so near the C.G.S. unit in size and yet not equal to it, will be awkward, and may lead to mistakes.

O. J. L.

University College, Liverpool.
January 15th, 1895.

Dear Prof. Lodge,—In reference to the sizes of the magnetic units proposed by you. I find that the weber 10^8 C.G.S. would only be used in fractions. The largest dynamo that I know of has a magnetic flux, or, as you propose to call it, an induction of ·5 weber. From this the value will go down to about ·01 in small motors. These figures are, however, by no means inconvenient.

Transformers will be rather smaller. In these the weber turn is a convenient size and an interesting quantity, as it is given by $\frac{1}{4}$ *of the mean volts per cycle*, or, more accurately expressed, *mean volts per unit frequency* $\div$ 4. Its numerical value will lie between, say, $\frac{1}{4}$ and 50, according to the volts and the frequency; but it gives no indication of the size of the transformer.

The henry 10^9 C.G.S. is also large. The inductance of choking coils would in general be fractions of a henry. The inductance of the winding of a transformer has no very important meaning, but it has a convenient size. Measuring it as *mean volts per unit frequency* $\div$ *four times the open circuit current in ampères*, the inductance of the primary coil on a 2 H.P. closed magnetic circuit 1,000-volt transformer would be about 40 henries.

The inductance of pairs of cables would run from 100 to 1,000 microhenries per kilometre, but the value would vary with the arrangement.

The induction per unit area is good; having a value in practical work from 1,000 to 20,000 C.G.S. units, it is given by 10 to 200 microwebers per sq. cm.

Gaussage would be about 50 in small transformers, up to 40,000 in large dynamos. The latter could be conveniently reckoned in kilogausses. To make the gauss = 1 ampère turn appears to have great advantages in practice, and connects it directly with its usual source.

The idea of permeance is very useful, and the identification of its dimensions with those of inductance is neat. But I think it is liable to cause confusion, for the permeance of the core of a coil will be a different number of henries from the inductance of its wire. Moreover, the argument as to identical dimensions might equally be applied to the case of ampères and gausses. I would therefore have a new unit strictly connected with the henry, so that inductance = $n^2 \times$ permeance in a coil of n turns.

As to the units of permeance: with the above meanings of gauss and weber, the permeance of a circuit would be $4\pi\mu\text{A}/10\,l$, as you point out, instead of $\mu\text{A}/l$. But I wish to suggest a change in the method of reckoning, namely, still to retain the value of the permeance as $\frac{\text{webers}}{\text{gausses}}$, and permeability as $\frac{\text{webers per sq. cm.}}{\text{gausses per cm.}}$, thereby in giving up the convention of unit permeability of space, and giving it the value $1{\cdot}2566 \times 10^{-8}$ unit of permeance for a unit cube. In this way both the troublesome 10^{-8} and $4\pi/10$ are dealt with in an easily intelligible way. To avoid the high power of 10, it may be measured in micro-units of permeance, so that permeability of space and air = ·012566 micro-unit of permeance for a unit cube, and permeability of soft iron = up to 25 micro-units for a unit cube. Thus we have permeance = $\text{A}\,\mu/l$, where μ is to be obtained from tables of its value, which can easily be altered to this method. Inductance then becomes $\frac{\text{weber turns}}{\text{ampères}}$, or $n^2\,\frac{\text{webers}}{\text{gausses}} = n^2$ permeance.

[Of course your phrase "weber turns per ampère" means the same as the above webers ÷ ampères, and does not necessarily mean the weber turns caused by 1 ampère.]

It may be objected that the C.G.S. units of strength of field, unit magnetic pole and intensity of magnetisation do not bear any simple relation to these practical units. This is chiefly important in the use of the magnetometric measurement of iron, and in the measurement of the mechanical form of attraction between two magnetic surfaces in contact. But the expressions are not in reality much complicated; *e.g.*, present C.G.S. unit of intensity of magnetisation is given by $4\pi\,\text{I} = (\mu - \mu_s)\,\text{H}$, where μ_s = permeability of space = 1, and H = C.G.S. unit of magnetic force. This becomes $4\pi\,\text{I} = (\mu' - \mu_s)\,\text{H}'\,10^8$, where H′ is the gauss gradient in the magnetic substance, and μ'_s = ·012566 micro-unit of permeance for a cubic centimetre.

As the single magnetic pole is unchanged, the force on it will be = strength of pole × gauss gradient × 1·2566; but as this is not a calculation of frequent occurrence, except in magnetic surveys, the complication will not be serious. Other magnetic relationships are almost entirely of academic interest only, and would be carried out in C.G.S. units. Also the transition would present no difficulties to people with a little scientific knowledge.

I am of opinion also that as the legal volt has no direct connection with induction and velocity of motion, it is not necessary to define the practical units as they are defined absolutely. That is, ohm and ampère are the starting points, volt is obtained from them, weber from volt, gauss from ampère, permeance unit from weber and gauss, henry from weber and ampère or from permeance, and so on. This is much more easily explained to practical and unscientific men than the absolute derivations are, and it is the order in which they learn them.

Yours very truly,

Francis G. Baily.

Postcript to Dr. Lodge's Letter.

Another subject for discussion is whether L had better not be defined as $d\,\text{N}/d\,\text{C}$; with permeability as $\mu = d\,\text{B}/d\,\text{H}$ to correspond. This would make the three equations stand thus:—

$$(1)\quad \text{N} = \int \text{L}\,d\,\text{C}$$

$$(2)\quad \text{E} = \text{L}\,\dot{\text{C}}$$

$$(3)\quad \dot{\text{W}} = \text{C}\,\dot{\text{N}}$$

A letter just received from Mr. Heaviside indicates that he would probably favour this course, and there is evidently much to be said for it. I need hardly add that he contemns my temporising method of dealing with the 4π nuisance.

O. J. L.

January 30th, 1895.

Magnetic Units.

According to the proposal of the Chicago Chamber of Delegates, the quantity which we call "inductance," and which is to be expressed in "henrys," is defined by the equation:

$$\text{E} = \text{L}\,\frac{d\,\text{C}}{d\,t} \text{ for self-induction,}$$

or

$$\text{E} = \text{M}\,\frac{d\,\text{C}}{d\,t} \text{ for mutual induction,}$$

both being comprehended in one definition, the inductance L or M being calculated by dividing E in volts by $\frac{d\,\text{C}}{d\,t}$ in ampères per second.

This implies that L or M is not to be defined as $\frac{\text{N}}{\text{C}}$, but as $\frac{d\,\text{N}}{d\,\text{C}}$.

I think names are desirable both for $\frac{\text{N}}{\text{C}}$ and for $\frac{d\,\text{N}}{d\,\text{C}}$. I would suggest that the former be called "the total inductance," and the latter "the differential inductance." The distinction would be somewhat analogous to the distinction between the "mean specific heat from 0° to $t°$," and the "true specific heat at $t°$." Both total and differential inductance should be expressed in "henrys," for they are quantities of the same kind, and when there is no iron, &c., in the field, they are equal.

I think that the above mode of definition, involving as it does no magnitudes except current and time, is more readily comprehended than Dr. Lodge's proposed definition, in which the magnitudes involved are current, flux of induction, and the number of convolutions of the coil through which the flux passes. In the definition proposed by the Chicago delegates, the consideration of the number of convolutions does not enter.

For a circuit, or two circuits, not having iron, &c., in the field, we may define inductance (in henrys) as the E.M.F. (in volts) due to variation of current at unit rate (1 ampère per second). When the field is modified by the presence of magnetic material, the above will be the definition of "differential inductance."

The "total inductance" for any specified strength of current will be the mean value of differential inductance for equal increments of current from zero up to the specified strength.

I would suggest similar nomenclature in the case of permeability $\frac{d\,\text{B}}{d\,\text{H}}$ should be called differential permeability, and $\frac{\text{B}}{\text{H}}$ total permeability.

In some respects, "mean" or "average" would be a more correct designation than "total;" but these words would be liable to be misunderstood as referring to an average taken over the different parts of the body or circuit. "Total" is to be understood as standing for "calculated on totals."

As regards the magnitude of the unit of inductance, while I agree with Mr. Heaviside and Dr. Lodge that the unit pole ought to have been so defined that the mutual force between two poles is equal to their product divided by the surface of a sphere whose radius is their distance, a definition which would have made the line integral of H, due to a current, C, equal to C itself, instead of to $4\pi\,\text{C}$, I deprecate a mixing up of the two systems. So long as we employ our present unit of intensity of magnetic field, which results from our present definition of the unit pole, we cannot consistently reckon the line integral as equal to the ampère turns. It must be reckoned as 4π times the ampère turns, and the flux N must be reckoned as $4\pi\mu$ times the ampère turns. The practical inconvenience of retaining the factor 4π cannot be considerable, for it is as easy to tabulate the values of $4\pi\mu$ as the values of μ.

Next, as regards "permeance." I do not think it can conveniently be reckoned in henrys. I would rather reckon it in "webers per ampère-turn" which would be written "web. per amptu"; and there can be no possible doubt as to the meaning intended, when once we have fixed the magnitude of the "weber." There seems to be no difference of opinion as to what this magnitude should be. It is fixed by the relation $\text{E} = \frac{d\,\text{N}}{d\,t}$, E being in volts, N in webers, and t in seconds. This is in accordance with Dr. Lodge's proposal, but Dr. Lodge has not explicitly recommended any name for the physical quantity which is measured in webers. Shall we call it "weberage"? It greatly needs a name; for "induction" may mean B instead of the surface integral of B, besides having many other meanings.

When permeance varies according to the strength of current, I would distinguish between "total permeance," $\frac{\text{N}}{n\,\text{C}}$, and "differential permeance," $\frac{1}{n}\,\frac{d\,\text{N}}{d\,\text{C}}$.

As regards "gaussage" and "gauss fall." I think the names will be convenient in the senses proposed by Dr. Lodge; but I cannot agree with his selection of a unit of measurement. The present definition of the unit pole (on which the present unit current is based) requires us to equate the line-integral in question to $4\pi n\,\text{C}$.

To be consistent we must reckon gaussage as equal to 4π times the number of amptus. Dr. Lodge's proposal is to reckon C not in ampères but in C.G.S. units, thus introducing, as it appears to me, an awkward breach of continuity.

J. D. Everett.

THE FIELD TELEGRAPH IN THE CHITRAL CAMPAIGN.

(*Read by* Mr. P. V. Luke, C.B. (Deputy-Director of Telegraphs in India), *before Section G, September 17th.*)

Before speaking of the operations of the Telegraph Department in Chitral, it is necessary to describe briefly the system upon which the military telegraph in India is worked.

Field telegraphy, as practised in India, is of two kinds, visual and electric. The former, known as "Army signalling," is a purely military organisation, and is the means of communication between the most advanced parties of troops themselves, and between them and the nearest electric telegraph office. The latter, known as the "Field Telegraph," is a civilian adjunct, working between the different camps of the advancing army, along the line of communication, and keeping touch with the general telegraph system of the country.

Army signalling by means of the heliograph, lamps, and flags, has been brought to a great state of perfection. Favoured by the clear atmosphere and prevalent sunshine of a hilly country, great distances can be worked over. With highly trained signallers a very fair speed of working is attained, and this method of telegraphing forms a most useful feeder to the electric telegraph. There is no wire for an enemy to cut and steal, and communication can be carried on between two stations quite independently of the occupants of the intermediate country.

D

The "field telegraph" required by the army in India for the many small campaigns in which it finds itself engaged from time to time is supplied by the Civil Telegraph Department. It differs in this respect from the field telegraph of the army in England, which is a military organisation under the management of the Royal Engineers. The Civil Telegraph Department in India is expected to meet all demands that may be made upon it by the Military Department, and it has therefore to be prepared and ready at all times with material and staff for any field telegraph that may be wanted.

The Supply of Material.

The principle adopted as regards a supply of material is first of all to design a suitable equipment, and then to keep a sufficient stock of it, ready in reserve at convenient depôts on or near the frontier, so that when a field telegraph is called for there may be no delay in getting the necessary stores up to the scene of action. In the event of unexpectedly extensive or prolonged operations, the whole resources of the Civil Telegraph Department are available to fall back on, and further supplies of material are sent up from the main depôts at Bombay and Calcutta.

Instruments and Equipment.

Ever since the Afghan war in 1879-80, in which the field telegraph played an important part, great attention has been paid to designing and perfecting a suitable and thoroughly practical field telegraph equipment. Owing to the physical difficulties to be met with in mountainous regions, and to the absence of all roads possible for wheeled transport, it is essential that everything should be arranged for "pack" carriage. The maximum weight for each package has been fixed at 80 lbs., which is one-half the load a mule is estimated to carry. The frequent small expeditions across the frontiers of India and Burma, which have been undertaken during the last 15 years, have afforded many opportunities for testing and improving the field telegraph equipment. On the close of each expedition a report on the efficiency, or otherwise, of every item of the equipment is submitted by the officer in charge of the operations, and all defects brought to light are, as far as possible, remedied before the

Fig. 1.—View of the Valley at Chitral.

next time a field telegraph is required. When the rough and mountainous tracks that have to be traversed, and the means of transport, camels, mules, or ponies, are considered, it will easily be understood that every article must be very strongly made and most carefully packed.

The receiving instrument generally employed is the "Sounder," practically the same as what is universally used in the Indian Telegraph Department, only reduced in size. It is fitted up in conjunction with a small relay and key, with connections so arranged that it can either be worked *direct*, or as a "local," as circumstances may dictate. This ordinary sounder is supplemented by Cardew's vibrating sounders, to be used when the insulation of a circuit is so low as to make working with the ordinary sounder impracticable. In addition to sounders, a certain number of sets of telephonic apparatus, of the most recent and approved pattern, and adapted to field requirements, are supplied and sent up from the base depôts, as required, to meet the case of short branch or temporary lines.

A perfect portable battery for field service has yet to be invented. At present the most suitable kind is one or other of the so-called "dry" cells. Till quite recently a special small form of Menotti cell has been used in India.

The unit of office equipment is the total requirements for one field office, including instruments, batteries, tables, tents, and line maintenance tools. The complete equipment for one office forms seven mule loads; but in case of scarcity of transport, all that is necessary for opening an office, and disposing of the traffic temporarily, can be carried on four mules, leaving the rest to be pushed on afterwards. This may, at first, seem an unnecessarily heavy equipment; but it has not been found practicable to reduce it. It must be remembered that provision is made for a line of a semi-permanent nature, and for dealing with a heavy message traffic. Every possible kind of climate has to be provided for, and the tents, both for the office itself, and for the staff, must be such as will afford efficient shelter under all conditions of heat and cold, wind and rain, or the health of the men is sure to suffer. Such a telegraph as is provided for must not be compared with what is employed during autumn manœuvres in England, which is perhaps rolled up at the end of a day, or a few days at most. It has to stand the strain of continuous work for months—perhaps through a heavy monsoon.

The wire used for the line is iron weighing 300 or 150 lbs. per mile, and stranded hard copper, weighing 80 lbs. per mile, according to the local conditions, which usually means "transport."

It may here be noted that the field telegraph has no special transport of its own. It is dependent upon the Transport Department for its pack animals. In all expeditions the greatest difficulty met with is in the mattter of transport, and therefore the necessity for keeping down weight as much as possible is paramount. On the other hand, it has been found inadvisable to use a very light wire in a difficult country, where storms are frequent, and baggage animals of all kinds are apt to knock up against the poles. Thin iron or copper wire leaves such a small margin of strength to meet unexpected strains, while steel wire is difficult to manipulate, and inclined to kink in coiling and uncoiling. Light field cable forms a part, and a most valuable part, of the equipment. For running through heavy jungle, where it can be suspended among the trees, or for paying out along the ground temporarily, when necessary to finish quickly into a camp at night, it answers excellently. If used otherwise than temporarily, however, it must either be buried, or raised on poles or trees, or it is certain to be wilfully cut or accidentally broken.

As supports for the wire, the local resources of the country traversed, in the shape of trees or saplings, are utilised to the utmost, in order to save transport; while to provide for conditions when the country is open and bare, and no supports can be procured on the spot, or in the immediate vicinity, an iron pole has been designed, and is manufactured in the Departmental workshops. It is a tubular pole made of sheet iron, in four sections, fitting into each other telescopically for convenience of carriage. A complete pole makes a package 5 feet long, weighing 40 lbs. When fitted, this pole has a length of, approximately, 18 feet, and when planted 20 to the mile, will safely carry three light wires of the size described. When iron

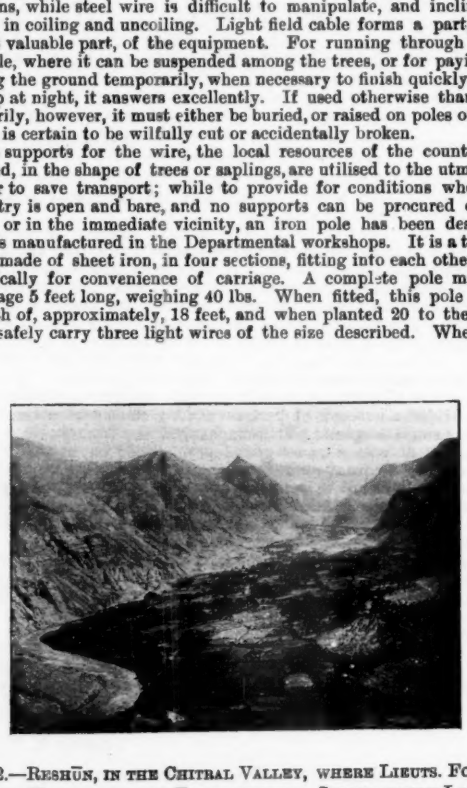


Fig. 2.—Reshūn, in the Chitral Valley, where Lieuts. Fowler and Edwardes were Treacherously Seized while Looking on at a Game of Polo.

poles are used, it is, of course, necessary to insulate the wires, and a special field insulator, of porcelain, very strong, and fairly light, is employed. Even when wooden poles are used it is better to insulate. In fact, if a line is required to work through the rainy season, it is *essential* to do so, or even vibrating sounders will fail to work. Only under special conditions, with a single wire on wooden poles in a dry climate, can insulation be safely dispensed with. A special bracket, in the form of a spike, for driving into trees to take the field insulator, has been found most useful.

All the tools for constructing and maintaining a field telegraph line have to be specially designed for the purpose. Ladders, wire reels, digging tools, &c., must all be suitable for pack carriage, and capable of being arranged in mule loads of the proper weight.

Speed of Construction.

The speed at which a line can be constructed, with material such as described, depends chiefly upon the transport and labour procurable, and upon the nature of the country traversed. Heavy jungle, that must be cleared to make a way for the wire, always retards rapid progress. During the campaign in Waziristan in 1894, a single wire was put up at the rate of nine miles a day for five consecutive days, in fairly open country, using poles procured locally. A line of a *very* temporary nature can be run up at a greater speed than this under favourable conditions; but such a line, if required for any length of time, will have to be reconstructed or altered. It must be borne in mind that unless a field line is strongly made in the first instance, along a well chosen alignment, the subsequent difficulties of maintenance will be great, and interruptions frequent. It must also be remembered that in India the existence of the Army Signalling Department does away, to a great extent, with the necessity for a *very* rapid construction of the field telegraph.

Maintenance and Repair.

Wire cutting is always a favourite amusement with frontier tribes; they find the wire so useful. Sometimes, too, they convert the hollow iron posts into guns, by lapping them round with wire. They also cut the wire up for bullets. The relations with the tribesmen are often of a semi-hostile nature. Men who work on the roads during the day will go away, on being paid up, and take their jezail, or long gun, from some hiding place, and fire into the camp at night. Once, in Afghanistan, an engineer officer, who employed many men of the country in road making, chaffed one of them on the bad shooting they made, and the man replied: "What can you expect, sahib, when we have only got old telegraph wire for bullets."

The maintenance of a field telegraph line is quite as important as its construction, and in order to repair wilful or accidental damage, and prevent undue delay to messages, it is necessary to have a field telegraph office every 10 or 12 miles, quite independently of the traffic requirements. At each office a supply of spare material is kept, and two or more trained linemen, who patrol the sections under the protection of the daily convoy, and are ready always to go out at once, with a suitable escort, when an interruption occurs.

Operating Staff.

In order to keep up a supply of signallers for working field telegraphs, it is the custom in India to train as many British soldiers as possible in electric telegraphy, and to employ them, when qualified, in the different telegraph offices of the country, usually at places where their regiments are stationed. They are paid according to qualifications, at a rate sufficiently liberal to make the service a popular one, with the result that there is always a large body of qualified military signallers from which to select men for field service. These soldiers, with a small proportion of highly trained civilian signallers for charge of the larger offices, form the operating staff.

The Engineering Staff.

The Telegraph Department supplies the engineering staff for constructing and working the lines, and all arrangements are under the management of the Director-General of Telegraphs. In any expedition the field telegraph forms a distinct department under a telegraph officer, who is appointed by the Director-General of Telegraphs, and who takes his orders in the field direct from the general officer commanding, or chief of his staff.

There is always a squad of sappers and miners attached to the Telegraph Department for instruction in telegraphy, and, should the magnitude of the operations make it necessary, the military authorities place at the disposal of the Director-General of Telegraphs the officers, non-commissioned officers, and native sappers who are qualified, and may be required by him, to complete the strength of the field telegraph establishment.

Base Depot.

As soon as a campaign is ordered, the place which is nearest the scene of action, and at the same time in telegraphic connection with the whole telegraph system of the country, is selected as the base of operations for the field telegraph, and all the stores likely to be required for a line of the estimated length are at once sent to it from the nearest reserve depôt. Here they are taken over by the chief telegraph officer in the field and his staff, and sent forward as required and as transport is available.

Preparations for Chitral.

To come, now, to the Chitral expedition. As soon as information was received by the Director-General of Telegraphs that a force was to be mobilised, and that a field telegraph was required, the material for a two-wire line, 200 miles in length, with 20 field offices, was at once sent off to Hoti-Mardan, which place, being in connection with the telegraph system of the country, was selected as the base of operations. At the same time the necessary staff for constructing and working the line was equipped with field clothing and ordered up, either to the base or the nearest large telegraph offices, to be ready when wanted.

Hoti-Mardan, our frontier station towards Chitral on the south, is about 14 miles from the nearest railway station at Naoshera, with a cart road between the two places. Only a single wire telegraph line existed between these two places. The first thing to be done was to reconstruct this section of line with three wires, and, by quadruplexing and duplexing existing circuits between Naoshera and the nearest large telegraph centres, to provide for the heavy traffic which had at once to be dealt with.

The Start.

The field line was started from Hoti-Mardan, and pushed on as fast as possible, crossing the frontier on April 1st. The Malakand Pass was crossed on April 6th, a telegraph office having been opened at the top of the Pass very shortly after the fight. The Swat river was reached on the 10th, and the Panjkhora, 63 miles, on the 14th. The Jambatai Pass was crossed on the 22nd, after some delay on account of military difficulties, and an office was opened at Dir, 113 miles, on the 27th. The Lowari Pass, 10,500 feet, was reached on May 3rd. This pass was not possible for camels, and all the camel transport was sent back from here. Owing to there being no mules available for the purpose, the telegraph stores could not be taken over the pass till May 14th, with the result that Chitral fort—184 miles from Hoti-Mardan—was not reached until midnight on May 17th. As the general officer commanding the troops got to Chitral on the 16th and left on the 18th, this delay was a great disappointment to the officer in charge of the telegraph. A single wire was put up in the first instance; but the heavy message traffic made it necessary to add others, and eventually there were three wires from Hoti-Mardan to Khar on the Swat River, 34 miles; thence to Dir, 79 miles further, two wires; and on to Chitral, 71 miles more, one wire. In all 327 miles of wire was put up on 184 miles of posts, and 26 field telegraph offices were opened. The actual speed at which the line was constructed may be taken as an average of five miles a day for 37 working days, but the actual distance covered in a day often exceeded this.

Nature of the Country.

Taking the whole line into account, the country was not a very difficult one for a telegraph. In the Jandoul, Panjkhora and Swat Valleys, the heat experienced was intense, and there was a good deal of dysentery and fever. When putting up the second and third wires in the Hoti-Mardan to Khar section, the work had to be stopped altogether between 10 a.m. and 4 p.m. Most of the troops, at any rate the Europeans, were moved up as soon as possible to hill stations on the Malakand, Laram, Jambatai, and Lowari Passes, to elevations of 4,000 feet and upwards, where they were better off than in the plains of India.

Wire Cutting, &c.

Curiously enough there was, at first, great freedom from wire cutting, due perhaps to the severe lesson of the Malakand fight; but in May the trouble, which experience in other campaigns foreshadowed, began, and up to the beginning of July interruptions aggregating 6½ days were caused by the cutting and stealing of the wire. The latest advices from India show that up to the middle of August the cutting of the wire at frequent intervals still continued. Most of the cutting has been in the Jandoul Valley, the home of Umra Khan, by which route the telegraph was originally taken. Jandoul has now been evacuated, and the wire removed to follow the Panjkhora River route, and it was expected that there would then be fewer depredations of this kind. Considering that storms were frequent and violent, there have been very few interruptions caused by them. At first, a good deal of trouble was experienced from camels and other transport animals, rubbing against the poles and breaking them. A little summary justice dealt out among the owners of offending animals had the effect of diminishing interruptions from this source.

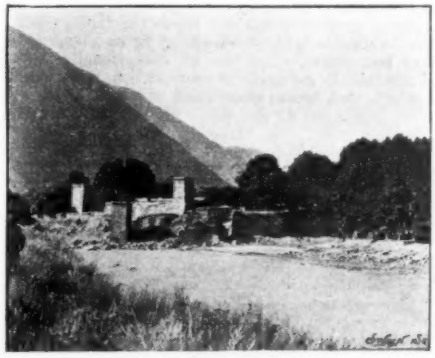


Fig. 3.—Chitral Fort, where British Force was Besieged.

Message Traffic.

There was great difficulty in working off the very heavy message traffic, especially at the beginning, when the staff were new to the work. The messages were unusually long, the number of words in each averaging over 50, which is about double the average of the ordinary messages in India. In April, the number of messages passing over the field line was 24,370, and in May 58,935, and doubling these figures for the purpose of comparison, it would be seen that the traffic was very heavy for a field line. The increase in State messages for the month of March for all India, as compared with March, 1894, although active operations did not commence till the close of the month, was 28 per cent. in number, and no less than 107 per cent. in their value. This increase was chiefly in the Punjaub, where the State work, as compared with 1894, increased nearly fivefold, and it will give some idea of the use that is made of the telegraph in time of war.

Long Distance Working.

One day in April, shortly after the Malakand fight, the telegraph line was cleared between Simla and Sadon on the Panjkhora River, a distance of 596 miles, to enable the Commander-in-Chief in India to talk direct with General Low commanding the Chitral relief force. Notwithstanding that heavy rain was falling in the Swat Hills, the communication was excellent; a great deal of work was done, and the military authorities expressed themselves as highly pleased with the efficiency of the service. Newspaper correspondents grumbled a good deal on account of the precedence always given to State telegraphy. It will, however, be generally admitted that the public in England was kept pretty well up to date as to what was going on in Chitral, and when it is mentioned that a telegram, dated Fort Chitral, May 19th, was published in a London paper of the same date, it cannot be said there was much to complain of, and it may be inferred the service has been a pretty good one.

The Waziristan Expedition.

The strain put upon the Civil Telegraph Department by the Chitral expedition was greater than it would have been, for the fact that, when it began, the Waziristan expedition was not finally concluded. For this little campaign field telegraph lines were constructed from Tank to Wana, *via* Shaharzan, and from Bannu to Dotoi, *via* the Tochi Valley, aggregating 139 miles of line, on which 26 offices were at different times opened. Owing to the dismantlement of these lines not being completed when the Chitral telegraph was called for, a good deal of field equipment was locked up, and a considerable staff was employed in Waziristan, and therefore not available.

The Gilgit Line.

The news of Dr. Robertson being beseiged in Chitral was brought by the telegraph from Gilgit, and it will not be out of place to say a few words about this line, which traverses perhaps the most difficult country for a telegraph of any in the world. The line from Kashmir to Gilgit is 228 miles in length, and its construction was finished in the summer of 1894. Two passes have to be crossed, the Rajdiangan, 11,600 feet, and the Burzil, 13,500 feet. On the former the snow lies in winter to a depth of 10 to 14 feet, and on the latter to a depth of 18 feet, and the poles have to be 30 feet long. Nearly the whole route is subject to avalanches, and the variations of temperature are very great. With the best constructed line total immunity from interruption is impossible under these conditions, and every conceivable arrangement for promptly restoring communication has to be made. To this end offices of observation have been established on either side of the passes, with two Europeans at each and suitable native establishments. During the winter, when the passes are closed, these men are entirely cut off from all communication with their fellow creatures, except by wire. They are rationed and clothed as if for a seige, and supplied with everything to render their vigil of some five months as endurable as possible. When an interruption occurs they have to go out and, often at great personal risk, repair the fault, which, in most cases, is due to the line being carried away by an avalanche. During the whole of last winter, which was an exceptionally severe one, it was found possible to maintain communication with Gilgit almost uninterruptedly, such breaks as occurred being repaired within one

Fig. 4.—Men of the Country.

or two days, according to the damage done and the duration of the storms, which, while they lasted, made it impossible for the men to leave their houses. Shelter huts have been built at the most dangerous places, and so far no accidents to life have occurred, and the possibility of maintaining telegraphic communication under these most arduous conditions has been fully established.

Recognition of Civilian Services.

In India every man is more or less a soldier, and with those serving in the Telegraph Department this is particularly the case. The work done for the Military Department during the last 25 years has always been fully recognised and acknowledged. Some 400 medals and decorations have been awarded at different times to civilian members of the Telegraph Department, a record enjoyed by perhaps no other civil service. Service in the field is attended with much hardship and privation, and no little danger; but there has never been any want of enthusiasm or readiness on the part of the civil staff to undertake it with cheerfulness and alacrity. On the contrary, the difficulty has been to select men from the number of volunteers all eager to go to the front. The sphere of usefulness of the telegraph department as regards military operations has been steadily increasing, and the field telegraph has become an absolute necessity for the efficient conduct of any campaign.

Experience Utilised.

It is fully recognised that there is no finality in the preparations for a field telegraph. Improvement in the equipment will from time to time be found possible, and it is the constant aim of the officers of the Telegraph Department to take full advantage of the experience gained in each expedition, as well as of the newest inventions emanating from Europe and America, to enable them to bring the field telegraph service up to date, and to make it as efficient as possible.

Protection of Sentries and Camps.

Besides the field telegraph, there are other ways in which the Telegraph Department is able to render assistance. It frequently happens at camps in an enemy's country that thieves creep up and steal rifles, or sometimes a sentry is shot or stabbed at his post. Trial has been made on the Chitral line of communication of running at night a wire round a camp close to the ground. It passes freely through staples in short posts planted at intervals, and is tightly strained. Triggers clamped to the wire are so arranged that they make a contact at certain fence posts with wires from the centre of the camp, and ring a bell in the quarter guard. The wire surrounding the camp is in sections, and indicators in the quarter guard show from which section the bell has been rung. Any person or animal coming against the fence wire causes the bell to ring and an alarm is given. The wire is taken up during the day when it crosses roads or interferes with ordinary traffic.

Wires are also put up from the centre of the camp or fort to the circumference in the directions taken usually by the outlying night pickets. From the fort wall or camp boundary, each picket going out joins on a light field cable, to be paid out from a barrow on which is fixed a bell-push. On reaching the position a bell is rung, and an indicator in the quarter guard shows the safe arrival of the picket, and rings at intervals denote that all is well, or an alarm can be given as the case may be.

There are many electrical devices which, when the men are properly practised in their use, cannot fail to prove of great assistance in protecting camps and giving alarms, and attention is being paid to this branch of field telegraphy.

LONDON COUNTY COUNCIL AND METROPOLITAN ELECTRIC LIGHTING.

Loans, Extensions of Mains, and Transformer Chambers.

The Council met on Tuesday for the first time after the summer vacation, under the presidency of Sir Arthur Arnold.

Among the loans announced by the Finance Committee as having now been completed, may be mentioned those of £51,000 to the Vestry of Islington for electric lighting, and £30,000 and £26,100 to the Vestry of St. Pancras for electric lighting and for land and buildings for dust destructor respectively.

New Mains and Street Boxes.

During the recess the Highways Committee, who in that period were authorised to act for the Council, have dealt with various applications received under the Electric Lighting Acts and Orders. Of the various notices given under these Acts, it may be well to refer to one, more particularly as the Council has now laid down a rule in regard to the provision of efficient means of ventilating street boxes.

The London Electric Supply Corporation, for instance, desired to lay a supplementary main from the Trafalgar Square station to the corner of Northumberland Avenue. Among the conditions laid down in sanctioning this extension may be cited the following:—That the works shall be carried on continuously by day and night until completed; that the mains be laid under the footways, and be kept 9 inches below the underside of the paving wherever practicable; that where the mains cross the carriageway they be kept at the same depth below the concrete or the road material as the case may be; that no pipes of larger size than 5 inches shall be used; that no street boxes shall be constructed until the positions for, and the mode of construction, showing adequate provision for ventilation of them shall have been submitted to and approved by the Council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines, or small cables, shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes be provided with an inner cover sheathed with wood or other non-conducting material, as well as an outer cover, the two to be insulated from each other as far as practicable, and the outer cover efficiently connected to earth.

Somewhat similar conditions were imposed in the case of the House-to-House, the Kensington and Knightsbridge, the Metropolitan, and the Charing Cross and Strand Companies.

Transformer Chambers.

On this point, the Highways Committee expressed chagrin at the recent award of the Board of Trade in regard to the appeal of the County of London and Brush Provincial Electric Lighting Company against decisions of the County Council.

It will be recollected that in July last this company asked the Board of Trade to give a definite decision on the subject of their appeals, which were the subject of an inquiry by the Board in the previous December, against decisions of the Council formally disapproving of the construction of 42 transformer chambers of large size under the surface of the streets in St. Luke's and Clerkenwell.

The Council authorised the committee to take measures for making known at the Board of Trade inquiry the Council's objections to the transformer chambers being placed under the streets, and for this purpose to employ counsel; and these objections were accordingly fully stated at the inquiry which took place before Major Cardew. The award of the Board of Trade was given on September 12th, and after reciting the facts, allows of the construction of 25 of the transformer chambers upon condition: "(*a*) That the said transformer chambers be constructed in accordance with the drawing marked "F" attached to this order; and (*b*) that there shall be no gas pipe within such distance from any box as is equal in feet to the diameter of the gas pipe in inches." The Board, further, disallowed the appeal in respect of the construction of 17 transformer chambers specified in the order, and disapproved of their construction.

Upon this decision, the Highways Committee on Tuesday stated that this conclusion to allow the construction of large chambers was to be regretted, and they put the responsibility of the ultimate result upon the Board of Trade.

Since then, however, the County of London Company have altered the position of 12 of the 17 chambers proposed to be constructed, and which were disapproved, and these 12 have now been approved; but of the remainder, three, left in their original position on the plans, have not been sanctioned, whilst no further application has been made in the case of the other two projected chambers.

But when we come to the Wandsworth district, the Council appears to reverse its policy of opposition. Here the company gave notice of intention, under the provisions of the Wandsworth order, to construct four transformer chambers at the corners of Colnette Road and Upper Richmond Road, and of Carlton Road and Putney Hill; on Putney Hill near Kersfield Road, and at the "Green Man" public house. In this case the committee sanctioned the works upon the conditions prescribed by the award of the Board of Trade given on September 12th, 1895, viz., (*a*) that the said transformer chambers be constructed in accordance with the drawing marked "F" attached to the award, and (*b*) that there shall be no gas pipe within such distance from any box as is equal in feet to the diameter of the gas pipe in inches.

Subways for Telephone Cables.

It appears that the National Telephone Company has applied for additional space in the subways of Queen Victoria Street, Victoria Embankment, Shaftesbury Avenue, and Charing Cross Road for the laying of cables. The company finds that the space it now occupies in the subways is insufficient for its requirements, and asked that it may be allowed to occupy double this amount. The company also desired to connect its cables in the Northumberland Avenue subway with those in the Victoria Embankment subway, and to utilise for this purpose some pipes which were laid down by the Council for the Home Telephone Company, which has been recently absorbed by the National Telephone Company. The Council decided that upon the company entering into an agreement to pay rent in respect of the user of the subways according to the scale laid down by the Council, and also to pay the outstanding charges (if any) due from the Home Telephone Company in respect of the pipes laid down by the Council for that company connecting the Victoria Embankments and the Northumberland Avenue subways, the company be allowed to occupy the further space in those subways applied for, and also to use the connecting pipes, on condition that all work in or about the subways shall be carried out under the supervision of the Council's chief engineer at the sole cost of the company, and that any damage that may be done in or about the subway in the execution of the work shall be made good by the company to his satisfaction.

The question of electric bells was also discussed, but the important matter of the lighting of the Thames Embankment remains in abeyance for the present. It will probably not be brought forward again for two or three weeks.

CORRESPONDENCE.

Localisation of a Fault by Kennelly's Method.*

The following formula, based on Kennelly's law that the apparent resistance of a fault is inversely proportional to the square root of the current passing through it, is rather more simple than that given by Kennelly, and results can therefore more easily be worked out.

It is a particular and a simple case of Kennelly's law; that is, if the current passing through the fault be quadrupled, the apparent resistance of the fault is reduced by one-half, consequently the *difference* between the two resistance values (obtained in the cable circuit with testing currents bearing the ratio of 4 to 1) subtracted from the *lower* resistance obtained with the stronger current, will give the distance of the fault from the testing station, thus :—

$$R_2 - R_1 = \tfrac{1}{2} \text{ resistance of fault } f = \frac{f}{2}$$

$$R_1 - \frac{f}{2} = x \text{ : or } R_2 - f = x.$$

Under the foregoing conditions the relative current strengths do not enter into the formula, which is absolutely correct, and in fact gives the same result as Kennelly's more elaborate formula,* provided that the two testing currents bear to each other the fixed ratio of 4 to 1, and are of a strength not exceeding 25 milliampères, on which latter condition the ordinary Kennelly's formula is based.

Example 1.—Actual Test on Submerged Cable.

First Test.

With 20 cells c_1 = 187 divs. R_1 = 3,154 ω
With 5 cells c_2 = 45 divs. R_2 = 3,185 ω
} Balancing to immediate false zero.

By Kennelly's formula.

$$\frac{R_1\sqrt{c_1} - R_2\sqrt{c_2}}{\sqrt{c_1} - \sqrt{c_2}}$$

$$x = \frac{3{,}154\sqrt{187} - 3{,}185\sqrt{45}}{\sqrt{187} - \sqrt{45}} = 3{,}123{\cdot}9\ \omega.$$

By simplified formula.

$R_2 - R_1 = \frac{1}{2}$ res. of fault $f = \frac{f}{2}$

$R_1 - \frac{f}{2} = x$ or $R_2 - f = x$.

$3{,}185 - 3{,}154 = 31 = \frac{f}{2}$

$x = 3{,}154 - 31 = 3{,}123\ \omega.$

Second Test.

With 40 cells c_1 = 365 divs.
R_1 = 3,142 ω.
With 10 cells c_2 = 92 divs.
R_2 = 3,164 ω.

By Kennelly's formula x = 3,120 ω.

By simplified formula x = 3,120 ω.

Third Test.

With 20 cells, c_1 = 697 divs.
R_1 = 3,134 ω.
With 80 cells, c_2 = 186 divs.
R_2 = 3,147 ω.

By Kennelly's formula, x = 3,120·5 ω.
Mean of three tests = 3,121·46 ω.

By simplified formula, x = 3,121 ω.
Mean of three tests = 3,121·33 ω.

In the following examples, a fault was made in a piece of cable core in salt water in circuit with an artificial cable.

Example 2.

48 cells, c_1 = 412·5 divs. R_1 = 2,099 ω
12 cells, c_2 = 108·5 divs. R_2 = 2,185 ω
} Balancing to false zero.

Distance to fault by Kennelly's formula = 2,008 ω.
" " simplified " = 2,013 ω.
Measured res. of artificial line to fault = 2,010 ω.

Example 3.—(Using Simplified Formula Only.)

36 cells and 9 cells gave, respectively, R_1 = 3,182 ω,
R_2 = 3,338 ω, from which x = 3,026 ω.
40 cells and 10 cells gave, respectively, R_1 = 3,175 ω,
R_2 = 3,358 ω, from which x = 2,992 ω.
48 cells and 12 cells gave, respectively, R_1 = 3,145 ω,
R_2 = 3,287 ω, from which x = 3,003 ω.

Mean x = 3,007

Mean of three tests gives distance of fault = 3,007 ω.
Measured res. of artificial line to fault = 3,010 ω.
(Difference of 3 ω.)

In Example 3, a galvanometer was placed, as is usual, in the cable circuit, in order to indicate the limit of 25 milliampères—as previously ascertained by taking the constant of the instrument—beyond which the law does not hold good; but no readings for the current strength in each case were observed, as it was assumed that the cells used had practically the same E.M.F.; this, the exactness of the result shows to have been the case. Should, however, some of the cells available be old, or differ in E.M.F. for any reason, it will be desirable not only to reduce the E.M.F. of the testing battery to one-fourth for the second part of the test, by reducing the number of cells, but to have also the means of increasing or decreasing the current strength still further, within certain small limits, in order to adjust it exactly to one-fourth its former strength. This is effected by resistance coils in the battery circuit. If, for instance, a certain resistance be unplugged, through which the larger battery current circulates, this resistance may, for the second part of the test with the reduced battery, be either increased or decreased as required, to make up for any slight difference in the relative current strengths passing through the fault, so as to make the ratio in the two cases as nearly as possible 4 to 1. Whether testing by bridge or reproduced deflection, this resistance is placed in the battery circuit.

* See Kempe on "Electrical Testing," Fifth Edition, p. 263, and *Proceedings* Society Telegraph Engineers and Electricians, Vol. xvi., p. 86.

* Kennelly is responsible for the *law* only, and not for the *formula*; the latter is due to Kempe.—Eds. Elec. Rev.

As Kennelly's test is rightly considered to be of great value in localising faults, more especially when the cable is ruptured, I have ventured to call attention to the above simplified formula, which I have frequently employed, but do not remember having seen published in this particular form.

Herbert E. Cann.

Iron Losses in Transformers.

In your issue of the 20th inst., a letter appears from Mr. Weekes bearing on the above subject, in which he states that I have not done much to enlighten "Student," whose letter appeared in the Electrical Review of August 23rd.

I regret if I have failed to do this; but at the same time I must take exception to some of Mr. Weekes's statements.

His assertion that the date of the test does not affect the truth of the observation is misleading, as the following consideration will show:—

A person may make a series of experiments in an entirely new field of research. He fits up his apparatus in what he considers to be the best possible way, and record his results, and the means by which he arrived at them. Another person becomes acquainted with these particulars, and obtains results which differ somewhat from those obtained by the former experimentalist. There is a great probability that the later experimentalist, who has profited by previous experience and devised improved apparatus, obtains results which are more accurate than those arrived at by the previous observer, the persons in each case being equally well qualified.

It is difficult to reconcile Mr. Weekes's statement that "the iron losses due to hysteresis varies with the quality of the iron to a far greater extent than shown in the comparative curves published in your issue of August 23rd," with the words quoted by Mr. Kapp in his paper read before the Institution of Electrical Engineers.

Mr. Kapp says, referring to the curves of iron losses reproduced in the Electrical Review of August 2nd: "The upper curve shows the average results obtained in testing a large number of samples of plates from several iron merchants." The lower curve records the best result ever obtained by him. It will be noticed that the difference between the two curves, never very great, is really very small at low inductions.

Since Mr. Weekes made the experiments from which Mr. Kapp's curves were prepared, also the experiments recorded in Mr. Weekes's own book "for a fairly good sample of iron," he will probably be able to enlighten "Student" and others as to which curve he considers the most reliable for the purpose of estimating hysteresis losses.

One would be disposed to prefer Mr. Kapp's curve for "the average of a large number of plates" for this purpose, where it is possible to obtain plates tested by makers, and guaranteed for uniformity in their magnetic properties within reasonable limits; the natural course for any one engaged in the design of transformers would be to take these tests as a basis for his calculations.

George Adams.

Bedford, *September 23rd*, 1895.

Compounding Dynamos by Armature Reaction.

I notice in your issue of August 30th, 1895, which has just reached me, that Mr. W. B. Sayers, in commenting on my paper on "Compounding Dynamos by Armature Reaction," has unwittingly made the mistake of supposing that I did not regard the breaking down under heavy loads as due to the magneto-motive force of the armature overpowering the effect of the wound poles. He must have failed to notice the statement in relation to figs. 11 and 12 of my paper, which is—"Figs. 11 and 12 show a similar plotting for abnormal or extreme loads. The former shows how completely the wound pole has been broken down by armature reaction, and how the unwound poles have now become the chief working field poles, or, rather, how the armature winding itself has furnished the field for its own cutting." Mr. Sayers also confuses my statement which I made as follows:—"A further interesting consideration is the effect of dispensing with the wound poles altogether, and either neglecting to employ any reversing or commutating field while maintaining the brushes near the forward edge of the field poles which now remain," &c. In interpreting this statement he says:—"It therefore follows that if the *excitation* of the wound poles were to be dispensed with, the effective flux would vanish, and the machine become inoperative," &c. The italics are mine. Surely there is a difference between dispensing with the wound *poles* and dispensing with the *excitation* of the wound poles while leaving the poles in position. All of Mr. Sayers's reasoning, based upon this misconception, of course fails of being to the point.

Elihu Thomson.

Lynn, Mass., *September 20th*, 1895.

MORE CHIPS FROM A TRUE WORKSHOP.*

By LEONARD PAGET, PH.D.

So many of my electrical acquaintances and friends have expressed appreciation of the publication of one of Planté's letters in the issue of the *Electrical World* for August 10th, as to cause me to accede to their request for more of these chips from such a workshop.

Planté's figures show very conclusively that for a given weight of plate the capacity in ampère hours he obtained was not at all a small one. It has, however, been the fashion to regard a Planté cell as one of inherently small capacity. But we learn from the letter that has just been published (and dated June 16th, 1886) that Planté obtained 60,000 coulombs, "or more than 16 ampère hours" per kilogramme of lead. This corresponds to 7·257 ampère hours per pound of lead, a capacity that is not exceeded in any battery of like type upon the present market.

It is also supposed that this high capacity was attainable only by a long and tedious process of formation. In fact, one of the advocates of the Planté cell, who put several modifications upon the French market, proved very clearly that long and careful reversals of current were necessary to form a lead plate to its full capacity, for he showed that charging and discharging a lead accumulator for long hours produced very slow results. Here are some of his figures:

Hours.	Coulombs.
75	5,000 per kg. of lead.
100	5,500 " "
500	12,000 " "
1,000	19,000 " "
2,000	34,000 " "
3,000	49,000 " "
4,000	64,000 " "

These figures are very interesting, because they show that although the formation is slow at first (25 per cent. increase of time producing only 10 per cent. increase of capacity), that subsequently twice the time nearly doubles the capacity.

It was to overcome this initial slowness of formation that Planté constantly experimented. It is not true that his accumulator was always regarded by him (nor by others, for that matter) as requiring long periods in forming, for as early as August 28th, 1882, he communicated to the Academy of Sciences of Paris, a paper, entitled "On the Formation of Secondary Couples with Lead Plates." This paper reads, translated, as follows:—

"The operation I have designated under the name of *formation* of secondary couples, consists, as I indicated several years ago (*Comptes Rendus*, lxxiv., p. 592, 1872), in a previous electrochemical preparation of these couples, having for its object to deeply oxidise one of the electrodes, and to reduce the other to a state of metallic division that permits of more complete chemical action during the charge and discharge, and of accumulating, consequently, a greater quantity of the chemical work of a primary current.

"I have sought, since then, to perfect this operation. Studying the chemical actions that are produced in these couples, I have observed especially the transformation of a part of the peroxide of lead into sulphate of the same metal, under the action of the solution of sulphuric acid in which these couples are immersed (*Les Mondes*, xxvii., p. 425 to 477, 1872), a result recently confirmed by Messrs. Gladstone and Tribe, in an interesting work on this subject. I have

* New York *Electrical World*.

attempted to increase the capacity of accumulation by producing a previous galvanic deposit on the lead of the electrodes (*Les Mondes*, *ibid.*), in such a manner as to cause subsequently a deeper oxidising action of the primary current by reason of the exceptional porosity of electrochemical deposits. I have tried, to this end, the most varied combinations, and for the most part of insoluble and soluble compounds of lead, without obtaining any deposits of a sufficient coherence or adherence, and in which the electric contact with the electrodes would remain indefinitely insured. I have arrived finally at this conclusion, that the preferable system was to seek to transform the metal of the electrodes itself, in nearly all its depth, into galvanic peroxide of lead, on the one part, and into reduced lead, on the other part. I obtained this result by a series of changes of direction of the primary current, with intervals of repose between these changes ('Recherches sur l'Electricité,' § 53, *et seq.*).

"To give an idea of the effects obtained by this method, I should add that with a secondary couple already partially formed, and in which the lead weighed 1·5 kg. the discharge current, which initially furnished a deposit of about 7 grammes in a voltameter, gave, after a fresh change of direction, a deposit of 11 grammes, and, after an interval of rest and another change of direction, a deposit of 18 grammes, or 12 grammes per kilogramme of secondary couple, which corresponds to 36,000 coulombs.

"This is not the limit that can be attained, because a fresh change of direction determines a further increase of accumulated chemical work, and so forth. There is no other limit than the thickness of the plates of lead. Admitting that we seek to transform only one-half the thickness of metal, and to preserve the other half as the body of each electrode, and even assuming that the peroxide is reduced, during discharge, to the state of protoxide only, we should hope to obtain, by this method, a discharge current sufficient to deposit, per kilogramme of lead of the secondary couple, about 75 grammes of copper, which represents a rather considerable quantity of electricity.

"The system of changes of alternated directions has not only for its effect to increase successively the layer of peroxide of lead formed at the expense of the metal of one of the electrodes, but also to transform, to a corresponding depth, the other electrode into galvanically reduced lead, so that, during the discharge, whilst the hydrogen, provided by the decomposition of the water at the interior of the couple, reduces the peroxide of lead formed by the primary current, the oxygen oxidises at the same time an equivalent quantity of lead.

"We may explain, also, the efficacy of the intervals of rest between each change of direction, by considering that at the end of a certain time the plates of lead thus modified have become less good conductors at their surface. It results that, when we submit anew to the action of the primary current, this current will naturally follow, in order to traverse the liquid, the path of least resistance; it will not issue directly by the oxidised surface, but by the subadjacent metallic surface as far as where the liquid may have penetrated. It thus oxidises by the mere fact of its passage a new layer of metal, or it may also superoxidise little by little, the external surface already oxidised, or effect the inverse work of reduction, if the direction of the current has been changed.

"This method requires, without doubt, a rather long time, especially at the commencement. To facilitate the attack of the lead by the electrochemical action of the primary current, I have succeeded, by elevating the temperature of the liquid of the secondary couples, either previously to or during the action of the current, in accelerating their formation. But this employment of heat presenting some difficulties in practice, I have had recourse, finally, to another procedure, which has given very satisfactory results.

"This process consists in simply submitting the secondary couples to a sort of deep pickling in nitric acid, diluted with one-half its volume of water, and allowing them to be immersed in this liquid during 24 to 48 hours. The couples are emptied, washed very thoroughly, and filled with water acidulated with one-tenth of sulphuric acid, and submitted to the action of the primary current. By this immersion in the diluted nitric acid, a portion of the lead is doubtless dissolved; but the thickness of the plates is not notably diminished, and by consequence of the metallic porosity, the chemical action takes place not only at the surface of the lead plates, but also at the interior, creating new molecular spaces, and facilitating consequently the ultimate penetration of the electrolytic action of the primary current.

"Secondary couples thus treated will furnish in eight days, after three or four changes of direction of the primary current, discharges of long duration, such as, without the previous action of the nitric acid, they would give only after several months. . . . ."

A modification of this method was also discovered and applied by Messrs. Elwell & Parker, of England, who sought to obtain a consolidation of interests with Planté, for he writes subsequently to the author of this paper as follows:—

[Translation.]

Paris, 56, Rue des Tournelles,
June 26th, 1883.

Dear Sir,—I am in receipt of your letter of 21st and 23rd current, which last contained a statement as to Messrs. Elwell & Parker, that you ask me to explain to you.

These gentlemen having taken, in the month of August of last year, three weeks after me, a patent analogous to that which I had taken, for the rapid formation of my secondary couples by the aid of a previous treatment with nitric acid, have asked me to cede to them my rights, and they wish to mention my name, in order to recognise that it was very nearly my system that they were employing.

But this will not hinder me taking the greatest interest in the success of the improvements that you have made on the same, and with which you have also associated my name.

Accept, dear sir, the expression of my best devoted sentiments.

(Signed) Gaston Planté.

A NEW BATTERY ELEMENT.

Note by M. MORISOT, Presented by M. LIPPMANN.*

I have the honour to introduce to the notice of the Academy a new battery element, which seems to me an important one, on account of its electromotive force, which is greater than that of the usual couples, and also its current, which is practically constant.

This element is composed in the following manner:—

1. The positive pole is a plate of retort carbon, immersed in the outer vessel in the depolarising liquid. This is composed of one part of sulphuric acid, mixed with three parts of water, previously saturated when cold with bichromate of potash. Some crystals of this salt are held suspended in the upper part of the liquid in a short funnel.

2. A porous cell, immersed in the depolarising liquid, contains a weak solution of caustic soda (density = about 1·05).

3. The plate of amalgamated zinc, which is the negative pole, is immersed, within a second porous cell placed inside the first one, in a concentrated solution of caustic soda (density = about 1·25). This latter solution, suggested by M. Reynier in 1880, for the Daniell battery, raises the electromotive force of the same from 1·1 volt to about 1·6 volt.

The electromotive force of this element is 2·5 volts at the beginning; it afterwards keeps above 2·4 volts during at least 10 hours of uninterrupted action.

The internal resistance is about ·8 ohm; it varies, moreover, with the thickness and the structure of the porous cells.

In the experiments that I made, the quantities employed were:

For the depolarising liquid 600 cubic centimetres.
For the diluted solution of soda 130 cubic centimetres.
For the concentrated solution 110 cubic centimetres.

Under these conditions the current was maintained very near the following values:—

For a resistance of 5 ohms interposed ·423 ampère.
" " 10 " " ·22 "

It therefore remained practically constant in both cases, notwithstanding the difference in the output. If the circuit is closed immediately after the setting up of the element, the resistance is at first greater, and consequently the current is less. The regular rate of working is established nearly an hour later, when the porous pots are sufficiently soaked.

* *L'Industrie Electrique.*

We obtain the definite rate of working at once if we do not close the circuit until after the soaking is complete.

It is the substitution of the alkaline solution for the acidulated water containing the zinc in the Poggendorff battery that raises the electromotive force from 2·1 to 2·5 volts. In fact, the same substitution made in the Bunsen battery gives 2·25 volts instead of 1·85 volt, *i.e.*, the same increase, viz., ·4 of a volt.

But if we confine ourselves to this change only, the advantage soon becomes deceptive, on account of the rapid increase of the resistance. The soda changes into neutral chromate, and we find on the zinc and round it an abundant deposit of hydrate of oxide of zinc. These actions, due to the modification of the liquids by one another through the pores of the porous pot, are considerably reduced, and their effect weakened by the interposition of the alkaline liquid contained between the two porous cells. This addition does not greatly increase the resistance, and it has the advantage of ensuring an almost absolute constancy, especially if we partly renew the weak solution of soda from time to time. This renewal is, moreover, necessary, as the level is soon seen to fall between the two porous cells. A good result is obtained by drawing off through a tube, about every three hours, a little of this intervening liquid which has become coloured, and restoring the level by means of fresh weak soda; I used 40 cubic centimetres for each renewal.

The employment of potash instead of soda offers no advantage, any more than the employment of bichromate of soda instead of bichromate of potash in the depolarising liquid.

I found that the zinc is much less attacked than in the Poggendorff element, and all those in which the metal is immersed in acidulated water. In this case the consumption of zinc is partly replaced by the consumption of soda. If there was an equal consumption of zinc, we should have an electromotive force of 3·1 volts; in fact, a normal couple, the zinc of which is replaced by a carbon, and in which the liquids act alone, gives 1 volt at the commencement.

After 10 hours of continuous action, we find the zinc covered with a grey crust. We can restore its polish and its original qualities by withdrawing it from the battery and immersing it, for a few moments only, in some acidulated water, which quickly dissolves this crust. The reconstituted element, even if the liquids are not changed or partially renewed, then resumes its action almost as at the commencement. We see that in this way the liquids could be used again for some time.

Lastly, I noticed that if the battery is to work for two or three hours only, for demonstration experiments, for instance, we can dispense with the amalgamation of the zinc.

CYLINDER CONDENSATION SURFACES.

A paper was read before the Institution of Naval Architects some time ago by Mr. Croll, wherein was discussed the question of cylinder condensation, with special reference to the nature of the surface of the piston and cylinder head, the combined area of which is considerably in excess of the area of the cylinder proper, and immensely greater during such time as the bulk of the initial condensation is in progress—to wit, during the early part of the stroke. It may be accepted, too, for present purposes, that the cylinder itself, in which works the piston, is of a quality and material not likely to be altered, being either of steel or iron, and as highly polished as the continual rubbing of smooth and more or less oily spring rings can make it. It is a well recognised physical fact that heat is radiated from, and absorbed by, surfaces with a rapidity that is very largely dependent upon the nature of the surface as to colour, material, and texture, quite apart from its absolute area. Of these qualities, we are considerably embarrassed in making a change, but by no means entirely so, and, in a sense, the quality of colour is dependent upon the ratio of nominal to absolute area. Mr. Croll does not use the term absolute area, but we judge he intends it, for he refers to the covering of a given triangular area with regular tetrahedrons as a means of trebling such area, the conception being that a rough surface may be considered covered by a series of microscopic tetrahedrons more or less perfect, the effect of which will be to multiply the absolute area exposed to steam when such rough surface forms the face of a piston or cylinder head.

The idea of smoothing and polishing cylinders and pistons is, however, not new. It was first set forth, so far as we are aware, by the author of "Hopkinson on the Indicator." He very clearly demanded the polishing of such exposed surfaces as a means to economy, and so far as can be reasoned out, there appears good ground to conclude that a bright and polished surface would condense less steam upon itself than the same surface rough cast.

The difficulty in the matter is rather one of permanence of the polishing, though we are not aware that any experiments have been made to test the permanence of nickel plating, for example, when exposed to hot steam. The inside of a cylinder would indeed be a much more suitable place for garish nickel plate than many exposed positions in which it is so plentifully seen. Mr. Croll states that a film of water $\frac{1}{10}$th of an inch thick upon the low pressure piston and covers will account for a 30 per cent. initial condensation, and he thinks that the nature of the surface will have much influence on this. Apart, however, from this question of surface, which may almost be said to include colour, seeing that an exposed surface must be either bright metallic or steam black; there is that of material. The specific heat and conductivity of materials differ widely. Comparing iron and brick, their specific heats are about as 2 to 3, but their specific gravities are about as 4 to 1, so that their specific heats per unit of bulk are as 8 to 3. Given, therefore, a lining of firebrick in place of cast-iron, it may be reasoned that initial condensation would be reduced to three-eighths.

But conductivity comes in and modifies this. Iron has sixfold the conductivity of the brick. The condensing power may therefore be not as 8 to 3, but as 48 to 3, and initial condensation in place of being about 32 per cent. would be only 2 per cent., modified, however, as between a smooth iron surface and a rougher surface of brick by the above-named absolute area ratio. Still there appears a prospect of securing an economy if we can find a substance which shall be capable of serving as a cylinder and piston liner. Aluminium, for example, from its lightness and brightness, appears an acceptable substitute for iron, and possibly may be, but it has a conductivity and specific heat, each about double those of iron, which more than neutralises its small specific gravity. Lead, on the other hand, though heavy, has a small specific heat, and small conductivity; its final coefficient referred to cast-iron being only about ·18, but lead presents difficulties of attachment by reason of its lack of rigidity and strength. Experiments by Osborne Reynolds showed that a small proportion of air fed into a boiler would greatly diminish cylinder condensation, for, as the steam condensed upon the cool surfaces, the air was left in contact, much as though it had been so many coarse particles kept back upon a fine sieve, which let particles of steam pass. The air film, infinitesimally thin, served to prevent condensation, and if it be true that condensation is to some extent governed by the mutual adhesion of the steam and iron, this is all the easier to understand; it is also all in favour of smooth surfaces.

Further, smooth surfaces have less powers of radiation than rough surfaces, and gain in this respect also. The difficulty with the air film is, of course, the reduction of vacuum, but this may be less than the gain from reduced condensation. The subject of the steam engine has been much debated, but there is ample scope for further experiment upon the lines indicated years ago in the book above referred to, and resuscitated by Mr. Croll, such investigations to be conducted upon the lines of the physical properties of the materials to be employed, as indicated above, with the addition of the radiating coefficient also.

The ease with which a surface of bright tin can be attached to iron should at least obtain for tin a good trial, as its general coefficient is good, though it has an unfortunately low melting point—little more than the temperature of many modern engines.

Bismuth, again, is good, and antimony especially so, with a coefficient only one-eighteenth that of iron, but it is very brittle, and this might prove too serious a disadvantage to be overcome. Probably some alloy may be found to combine the good qualities needed without the one doubtful quality that seems to attach to each of the metals cited.

Against all these considerations, which have as their basis the belief that an adiabatic cylinder is what is to be sought to improve the economy of the steam cylinder, may be set the reduction of the efficiency of the steam jacket. Steam jackets depend for effect upon a high conductivity, but there does not seem to be much weight to be placed on this argument, seeing that the absence of an absolutely adiabatic cylinder is the only excuse for the existence of a jacket, and the value of jackets is well known to diminish with increased piston velocity, or rather with the decrease of the exposure duration. At modern speeds the jacket effect is so small, that a serious reduction of the condensing power of the cylinder ends and piston faces, coupled with a small amount of superheat in the initial steam, will altogether eliminate the jacket from the field of practical considerations; and seeing that the jacket is in itself the carrying into effect of a bad principle, to wit, the application of heat to the working body at less than the maximum temperature, it may with propriety be urged that a part whose work is useful only so far as other parts are in fault, should, if possible, be removed. The steam jacket is a cause of much expense in construction and trouble in maintenance. Its application cannot even be held to have been properly carried out unless the steam supplied to the jacket be of higher temperature than the working steam. Too often it is rendered inefficient through bad circulation of the steam within it, or is choked with air, and some of the most efficient of triple engines have been unjacketed altogether.

There is little doubt but that the main cause to-day of the difference between obtained and theoretically possible efficiency coefficients is to be found in cylinder condensation, to the reduction of which it would certainly appear worth the while of engineers to experiment.

In pursuing his experiments, Mr. Croll found by inquiry among his friends that the most economical results were obtained where pistons and cylinder covers were of cast-iron, and the worst results when the material was cast steel—well known as a rough surfaced material. In cases, indeed, no diagrams at all could be obtained, so great was the wetness of the steam. He tried smoothing the surface with

varnish, in some experiments with a brass box, but the varnish made matters worse. It seems doubtful to us, however, if this experiment made with a smooth box of sheet brass can fairly be taken to represent what would be the effect upon rough cast-steel. However, the varnish seemed to treble the efficiency of the surface as an evaporator, and *per contra*, it was assumed, would be equally effective in promoting condensation. The increase is set down to microscopic cracks upon the surface of the varnish adding enormously to its absolute surface, while remaining smooth to the touch. Cast-iron polished, and the same rough, however, showed when tested in a similar manner that the polishing halved the evaporative power. Unfortunately, Mr. Croll has been unable to carry out experiments with a pair of paddle-wheel engines, which were set to drive the paddles independently, one engine having its interior parts polished, and one being left as cast; but he submits the general results of observations of engines with rough cast surfaces: of torpedo boat engines which have polished or smooth surfaces, and are so economical at all powers; of a pair of engines internally polished, designed by Mr. Martin, of Flushing, which gave practically equal economy at full load, and at one-tenth power, indicating small cylinder condensation; and of Messrs. Sulzer Bros.' engines, which are internally polished, and have given a horse-power hour for 11·73 lbs. of steam. Clearly Mr. Croll is in accord with the author above referred to. The writer has advocated the practice for many years, and met men of sound practical experience, who have been fully persuaded of the soundness of the practice.

The professorial treatment of cylinder condensation has almost invariably been in the direction of speed of piston or of reciprocation, without reference to the nature of the internal surfaces. When this remedy runs in the direction of rapid reciprocating speeds, it is obvious that the ratio of unpolished surface, or of the more or less dirty surface of the cover and piston faces, to that of the constantly polished working barrel, is very largely increased, and that a long stroke in a narrow cylinder may after all be better than a short stroke in a wide cylinder. In any case, if the theory of polish be sound, piston speed of either variety will have a lower limit, beyond which it begins to be doubtful wisdom to proceed.

To return to the question of the steam jacket, we never remember to have seen any discussion on this appliance, and its extremely dissimilar behaviour at different times, in which any reference has been made to the quality of the surfaces through which the jacket heat has had to pass. It would appear reasonable to suppose that the jacket's best results will be obtained, as a rule, in such engines as have the roughest internal surfaces, and do not condense so much steam as to throw the re-evaporation period into the return stroke. Such at least may be supposed the case where the jacket is hotter than the initial steam. If, however, by suitable choice of inner surfaces the initial condensation can be very materially reduced, it is possible that a comparatively small amount of superheat will then avail to rob the question of initial condensation of almost all its terrors, and go very far indeed towards that exceedingly desirable end, the ability to work a steam engine at light loads without the present enormous reduction in its economy. Here then is the opportunity for a new school of thought in steam working. Shall we call it the materialist school?

W. H. B.

BUSINESS NOTICES, &c.

Chloride Accumulators.—We have received from the Chloride Electrical Storage Syndicate, Limited, a price sheet of their new "R" type cell, which is fitted with a new type of plate lately introduced by the company. It is claimed that these cells are capable of being discharged at very high rates, and can be easily charged in four hours, effecting a great saving in the time formerly necessary, an advantage which users will appreciate. The list gives rate of charge and discharge, capacity, weights, and dimensions and prices.

Dissolutions of Partnerships.—Messrs. T. Ash and O. A. Beardmore, carrying on business as brassfounders and art metal workers at 175, Camden Street, Birmingham, as Thomas Ash & Co., have dissolved partnership by mutual consent. All debts owing to or by the said firm will be received and paid by Thomas Ash, by whom the business is to be carried on.

The partnership heretofore subsisting between D. J. Callow, electrical engineer, and W. A. Cloud, mechanical engineer, carrying on business as engineers at Pier Place, Strand-on-the-Green, as Callow, Cloud & Co., has been dissolved by mutual consent as from September 20th, 1895. All debts due to and owing by the late firm will be received and paid by D. J. Callow.

Liquidations.—At a meeting of the Railway Automatic Electric Light Syndicate, Limited, held at the Depôt, Mill Hill Park Station, September 19th, it was resolved that it having been proved that the syndicate cannot, by reason of its liabilities, continue its business, it is advisable to wind up the same voluntarily. Mr. John M. Tourtel, of the Depôt, Mill Hill Park Station, Acton, W., was appointed liquidator.

"Electrical Transmission of Power."—In our review of the book on this subject, in the September 20th issue, published by the Electrical Company, Limited, we stated that the publication "is really a well got up catalogue and hand-book." As this has caused a little misapprehension among readers who have written for copies, we are asked by the Electrical Company to state that the publication was not intended as a catalogue, but as a general treatise on the subject, with an appendix for the convenience of readers, including sets of queries and prices taken from a part of the company's catalogue.

Plant for Sale.—The liquidator of the Electrical Engineering Company of Ireland, Limited, is prepared to receive tenders for all or any of the residue of the company's stock, including generating plant, search light, gas engine, dynamos, Brush combined plant, accumulators, switches, meters, lamps, and a quantity of sundry fittings. Particulars from the liquidator, Mr. J. M. Kean, 46 and 47, Dame Street, Dublin. Latest day for tenders, October 10th 1895.

The New British Electric Installation Contractors.—A meeting of the creditors of this company was held on 1st inst. at the office of the Official Receiver, Worcester, Mr. Luke Sharp (official receiver) presiding. The summary of the statement of affairs shows, as regards creditors, that the company's gross liabilities are £4,363 18s. 5d., of which £3,922 16s. is expected to rank for dividend. The estimated assets are £441 2s. 5d.; deduct loans on debenture bonds secured on the assets of the company, £3,500; estimated deficiency of assets to meet the liabilities of the company, subject to the cost of liquidation, £3,922 16s. The Official Receiver said that the question for the creditors to determine was with regard to the appointment of a liquidator. He did not know whether there would not be something to liquidate. He had gone carefully into the articles of association, and he had very grave doubts whether the debentures would stand. After some discussion, it was resolved not to apply for a liquidator, nor for the appointment of a committee of inspection.

ELECTRIC LIGHTING NOTES.

Bermondsey.—The Capital and Counties Electricity Supply Company, Limited, have notified the Vestry of their intention to apply for a provisional order for public and private supply. The Vestry has the matter under consideration.

Belfast.—The increased consumption of current will necessitate laying down more plant at the central station shortly. The question of extending the mains into other thoroughfares is under consideration.

Blackpool.—We understand that Church Street was thrown into darkness on 26th ult. by the extinction of the electric light, which occurrence was followed by an explosion. It is supposed that sparks ignited gas which had accumulated in two transformer boxes. No one was injured.

Bristol.—The following figures will give a general idea of the progress being made here:—September, 1894, 8,833 lamps connected: September, 1895, 17,500 lamps connected.

Broadstairs and St. Peter's.—Messrs. Poole & White have asked the District Council to support their application for a provisional order, which would be worked by an association at present in process of formation. The Council will interview the writer of the letter.

Chelmsford.—On 21st and 23rd ult. there were slight failures in the street incandescent supply. We understand the Chelmsford Electric Lighting Company are confident that no further failures will occur, as Messrs. Crompton & Co. have a spare set of plant ready for use in case of an emergency.

Cheltenham.—The School of Science has lately been wired for electric lighting by Messrs. R. E. & C. Marshall. Lamps of 8, 16, and 32 C.P. are distributed throughout the master's room, physical laboratory, lecture room, chemical laboratory, corridors and lavatories.

On Wednesday, a continuous day and night service was commenced. Hitherto the station has been shut down at three or four o'clock in the morning and re-started at 11 a.m. The stoppage has been justifiable on the score of economy, having regard to the light day load the engineer has had to deal with, but the rapid increase of customers has led the Lighting Committee to accept responsibility for a continuous supply, which will be broken only, for the present, by a few hours' stoppage on Sunday.

Cork.—Three companies have given notice of their intention to apply for electric lighting provisional orders, but the Corporation seems to be disposed to keep the matter in its own hands, and on 25th inst. will hold a meeting to consider whether to apply for a provisional order itself.

Country House Lighting.—The electric lighting of Mr. C. C. Wyllie's new house at Esher has been placed in the hands of Messrs. Drake & Gorham. The plant will consist of a gas engine, dynamo, and a battery of 53 cells. In London, Major the Hon. E. R. Bourke has entrusted to the same firm the electric lighting of his house in Great Cumberland Place, where there will be about 125 lights.

Cowes (I.W.).—We learn from the *Surveyor* that Mr. Nelson F. Dennis, surveyor to the Cowes Urban District Council, has just presented to his Council a report on the electric lighting scheme. Tenders were asked for laying down an installation sufficient for a portion of the town from Medina Road to Egypt, a distance of over

1½ miles. Eleven tenders were received, ranging from £8,100 to £5,155. Three of the tenders are now under consideration; they comply with the condition that efficient power should be given to maintain 2,200 lights for private houses, and also the arc lights for street purposes, all burning at the same time. Messrs. Crompton and Co. (£6,215) propose a low tension three-wire system with accumulators. They would supply two Cornish boilers, with feed pumps, 1,000-gallon tank, steam exhaust, &c., five Crompton's continuous current dynamos, coupled direct to Willans compound engines, 60 horse-power each, and a Crompton switchboard. The mains would consist of insulated cables, made by W. T. Henley's Telegraph Company, drawn into pipes. There would be two feeding points, and the arc lamps would be provided with separate mains. Accumulators to have 130 cells, having a capacity of 42 ampères for five hours. Messrs. Sharp & Kent (£5,333) also recommend a three-wire system with accumulators. Arc lamps to be run in series of four, off wires fed from private lighting mains. Accumulators to consist of 110 cells, having a capacity of 110 ampères for five hours. The Electric Construction Company (£5,155) suggest a three-wire system with accumulators. Mains to be lead sheathed. Arc lamps run in series off private mains. Messrs. Crompton & Co. undertake to run their system for a year for £790, the Electric Construction Company for £860, and Messrs. Sharp & Kent for £750.

Derby.—A local paper says that the number of lamps lighted nightly exceeds 12,000, an increase of 4,000 during the present year. Every effort is being made to get the new plant into working order before the winter months.

Dundalk.—As will be seen from our remarks under "Contracts Open," and from the official announcement in our advertisement supplement, the Commissioners are inviting applications for the appointment of an electrical engineer.

Edinburgh.—The Cleaning and Lighting Committee intends recommending that the West Bow and the Grassmarket should be lighted by electricity. Electric lamps are to be erected at the corners of Picardy Place and London Road. Until some definite scheme of extension has been resolved upon, it is recommended that the request of the proprietors in Castle Terrace for the lighting of that thoroughfare by electricity should not be entertained.

Electric Lighting of Railway Trains.—The Great Northern Railway of Ireland have been making experimental trials for lighting their trains by electricity.

Hull.—A Local Government Board inquiry was held on 3rd inst. regarding the Council's application for a loan of £8,000 for extending the electric lighting station.

Leicester.—According to a statement made at the last Council meeting, the income from the electric supply has been £963, including £268 for the fittings business. The expenditure has been £863, showing a profit of £100 on the revenue account. After deducting interest and sinking fund, however, there was a balance of £951 on the wrong side.

Newquay.—The electric light installation at the Newquay Baths and Steam Laundry is exciting a great deal of local interest. The gas supply of the town continues to cause much dissatisfaction.

Norwich.—Regarding our statement in last week's issue that there was a slight failure in the private electric supply, Mr. F. M. Long, the engineer and manager of the Norwich Electricity Company, writes as follows:—"There was no failure here whatever, nor indeed has there been any since this company began to supply current two years ago." We are pleased to insert this correction.

Pembroke.—The Commissioners contemplate applying for an electric lighting provisional order or license.

Southport.—The Mayor started the new machinery at the generating station last Monday. The capacity of the station has been increased from 4,000 to 12,000 8-C.P. lamps.

Stafford.—The formal opening of the works will take place on October 15th.

St. Helen's.—A Local Government Board inquiry was held on 1st inst. regarding the application of the Corporation to borrow £10,000 for the purpose of the electric lighting of the main streets in the centre of the town.

St. Pancras.—A proposal was the other day made to the Vestry to light some of the streets of the parish by incandescent gas. We understand that the supply works at King's Road station are now practically completed, and as soon as the work of connecting is finished the supply will be turned on. Most of the destructor furnaces have been lighted for some few weeks for a few preliminary tests, and have been found to be generally satisfactory.

Tunbridge Wells.—There was a Local Government Board inquiry here on 24th ult. regarding the Council's application for a loan of £12,000 for extension of electric lighting works.

Woking.—A meeting of ratepayers in the St. John's District, last Friday, decided in favour of electric lighting. This would necessitate the extension of the mains of the electric light company.

Yarmouth.—The *Yarmouth Independent* says that there was a slight failure in the private supply one night last week.

Yeadon.—A public meeting was held last Friday to consider the electric lighting question. Mr. Medhurst, the electrical engineer called in by the District Council to advise on the tenders, recommended the Council to accept the tender and scheme of the Brush Company for £5,487, and with other charges to £7,282 for plant equal to the supply of 1,800 lamps, besides 146 street lamps. After discussion, it was decided to defer the question for three months, and in the meantime the District Council to ascertain what number of lamps they could get taken up.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Electric Railways in Canada.—The *Canadian Electrical News* has recently inquired as to the progress of electric traction on Canadian railways. These inquiries have shown that of a total of about 30 street and suburban railways in Canada, covering nearly 500 miles, the large majority are operated by electric power; only a few still hold to animal power.

Electric Traction in Austria and Hungary.—An electric tramway, about 3 kilometres long, has lately been completed at Gmunden. The generating plant comprises two Babcock & Wilcox boilers, two 50-H.P. Armington & Sims engines, and two 33-kilowatts dynamos. The line is on the Thomson-Houston overhead conductor system. The Union Electrical Company, of Berlin, is reported to have acquired the horse tramways in the town of Linz, with the view of converting them into electric lines.

Electric Traction in France.—It is proposed to construct an electric tramway between Champagne and Lyons (Rhône). Plans have also been prepared for an electric tramway between Francheville and Lyons. The question of the construction of an electric line between Mont Cenis and Le Creusot (Saone et Loire) is under consideration. It is proposed to construct an electric tramway between Arcachon and Mouleau (Gironde), a distance of nearly six miles. Plans have been prepared for the construction of electric tramways between Havre, Sanvic and Bléville, and between Havre, Harfleur and Montivilliers. The question of constructing an electric tramway between Lyons and Caluire is also at present under consideration.

Electric Traction in Italy.—Plans have been prepared for a narrow gauge electric tramway between Perugia and Cortona. The line will be about four kilometres long, and on the overhead conductor system. It is also proposed to construct an electric tramway between Varese and Luino, a distance of 24 kilometres.

Electric Traction in Germany.—A new electric tramway has just been completed and put in operation in Berlin, between Gesundbrunnen and Pankow. The line is on the overhead conductor system. An electric tramway has just been completed and put in operation between Dusseldorf and Rath. It is reported that the Hanover Tramways Company has decided to substitute accumulators for the "trolley" system on 28 of its electric tramcars. The contract for the accumulators has been given to the Hagen Accumulator Company.

Electric Traction on North Staffordshire Tramways.—A deputation of about 20 gentlemen, including the mayors of Stoke-on-Trent and Longton and representatives of the Hanley and Burslem Town Councils and of other local authorities in the Potteries, have visited Havre to inspect the system of electric traction there.

Hawaii Tramways.—Addressing the meeting of shareholders in this company last Monday, the Chairman (Mr. H. R. Armstrong) referring to the proposal for electric traction in Honolulu, said that although they obtained the necessary sanction some time ago, it had not yet been found that it could be employed with profitable results. They were, however, endeavouring to find out what the installation, &c., would cost; but they would not take any definite steps before consulting the shareholders."

Projected Tramway Extension at Douglas.—A provincial daily says that in consequence of the enormous traffic which there has been this year between Douglas and Kirk Braddan a number of influential Manx capitalists have had under consideration the advisability of constructing a tramway between these two places. A firm of eminent Glasgow engineers have had a representative at Douglas taking the bearings of the route, and the promoters of the scheme are assured that no engineering difficulty stands in the way of the working of either a cable, electric, or horse tramcar service.

Proposed Electric Tramway.—We learn from a local source that a rumour is in the air of a project for the construction of an electric tramway through Cheltenham, connecting Leckhampton on the one side with Winchcombe on the other, and providing for access to one or both of the two railway stations of the town.

Rathmines Proposed Electric Tramway.—There is a proposal on foot for laying an electric tramway from Rathmines to the sea at Merrion. Mr. J. H. Ryan, C.E., has stated that he is connected with a large electrical firm in London, who are prepared to lay the line and do all the necessary work, provided there is sufficient local encouragement. The inhabitants are to be circularised later on, and a meeting held.

Swansea Proposed Electrical Tramways. — The negotiations which have been carried on by the Swansea Corporation and the proprietors of the tramways for the purchase of the latter, have not yet reached, says the Swansea *Daily Post*, a definite point. Two years' time is still left for the municipal authorities to make up their minds what to do. The tramway company, in the event of another lease of 31 years being granted, will, we understand, undertake to re-lay the lines throughout, and give an improved service by means of electrical power. It is stated that the directors have already determined upon using electrical power instead of horses, and that as soon as a definite arrangement is made with the corporation, the necessary electrical plant will be secured. Their Act of Parliament gives them power to use either electricity or steam.

TELEGRAPH AND TELEPHONE NOTES.

A New Atlantic Cable.—A Reuter's telegram, dated Paris, October 1st, says:—"According to the *Figaro*, M. Lébon, Minister of Posts and Telegraphs, has announced to the members of the Calais Chamber of Commerce that he has signed a contract for the laying of a submarine cable from Brest to New York, which will be connected with the French telegraph system in the Antilles. The contract, which bears a large number of signatures, will be presented to the Chambers on the day when they re-assemble."

Bradford Telephones.—The Bradford Chamber of Commerce has joined with the Dewsbury and Halifax Chambers with a view to bringing about improvements on a number of points in the local telephone services.

Chilian Telegraphs.—The late Minister of the Interior for the last year reports the reconstruction of 1,322 kilometres of telegraph lines, at a cost of $120,250, and the construction of 545 kilometres of new lines, at a cost of $87,641.50. Forty lines also were repaired at a cost of $10,128.50. With this outlay the service has been much improved. Direct communication between the principal offices has been completely established, whilst in the secondary offices the system of turns has been abolished. Previously these turns were a necessity, owing to a deficiency of lines. One line more between Serena and Illapel, and the reconstruction of the line between those places, will complete the telegraphic network of the Republic, and will be sufficient for all present necessities. In 1894 12 new offices were opened, and three were closed for want of business. The number of messages transmitted in 1893 and 1894 shows a great increase over 1890, whilst the revenue in 1894 exceeded that of 1890 by $155,431.22. Similarly to the State railways, the telegraph lines of the Republic are the result of patient labour, extending over many years. The precursor of the network of these lines was the "linea Americana," between Valparaiso and Santiago, which was constructed little more than 40 years ago, and as a company concern proved a failure.

Siberian Telegraphs.—We learn that a telegraph line is to be established between Bachta and Tchugutschesk, in Siberia, which will primarily facilitate telegraphic communication with Western China.

Telegrams for the East Coast of Africa.—Last week we called attention to the inconvenience reported to be caused in business circles by the delay in South African telegrams, due probably to the breakdown of the Aden-Zanzibar cable, which has been interrupted since the 2nd of last month. In the *Times* of September 30th, a telegram from Zanzibar, dated September 27th, and giving particulars concerning the rising near Mombasa, is published with the foot-note, "delayed in transmission." Our readers will remember that this system of cables recently obtained from various Governments—the Imperial Government, amongst others—an extension of the subsidies at present paid to the Eastern and South African Telegraph Company. The last interruption to the Zanzibar-Aden cable occurred on December 21st last, communication being restored by January 10th. The cable uniting Mombasa to Zanzibar was also interrupted from September 4th, 1894, till November 28th last.

Telegraphs in Archangel.—We understand that the telegraph lines from Archangel to Kem are to be continued all along the White Sea littoral and the Murman to Vadsö and Vardö. The wires now in course of erection, says Mr. Vice-Consul Cooke, from Mezen to Ust-tsilma, the centre of administration of the Petchora districts, will thus bring the great outlying regions in touch with Archangel and with the world.

Telephone Extension in Germany.—The telephone exchange at Essen, the town famous for Krupp's gun factory, was recently fitted up with multiple switchboards manufactured and erected by Messrs. Mix & Genest, Limited, of Berlin, for the German General Post Office, the boards being for 6,000 subscribers. We are told that the telephone service has thereby been greatly benefited, as the attention is much more prompt, and less noise is noticeable at the exchange, the previously stereotype inquiries, "Have you finished?" not being needed with these patent multiple switchboards, as testing is done by galvanometers. The neighbouring towns of Dortmund, Bochum, &c., had been previously fitted up with multiple switchboards of the same system and manufacture, where the working has given every satisfaction.

The Islet of Trinidad.—From a Buenos Ayres paper, dated September 2nd last, we translate the following:—"According to recent notices from Brazil, the question of Trinidad is far from being settled in the way which the Press and the people of Rio Janeiro justly demanded, when they received notice of the occupation of Trinidad by English sailors. The Brazilian Minister of Foreign Affairs has procured from the English Government a declaration that there is no intention to annex the island to the empire of H.M. Victoria, but has not been able to obtain assurances that they will be relieved of a condition which is so mortifying to Brazilian patriotism. England reserves to herself the right to establish in Trinidad a telegraph station, and will shortly use this right, landing there the cable to which we have formerly referred. The surrendering of the island to Brazil under such a stipulation cannot be satisfactory to the Brazilian Republic, as the laying of a cable to that locality only means the thin end of the wedge, and soon we may expect to see a coaling station there for the British Squadron, and, finally, the incorportion of this island in the Great Empire. This question interests the whole of America sufficiently to prevent its being regarded as an insignificant incident."

The Japan-Formosa Cable.—This cable is now being manufactured by the Telegraph Construction and Maintenance Company. It is reported that it will be laid from Nagasaki to a point in the north-eastern extremity of Formosa, *via* the Lu Chu group of islands. The first portion of the cable, 236 nautical miles, will be shipped on board the repairing steamer which the Japanese Government are at present having built in this country; the balance, 558 miles, is to be delivered in store tanks out at Nagasaki.

The Telephone on the Battlefield. — The *Daily Chronicle* says that an interesting experiment of installing a telephone by trotting cavalry was recently successfully undertaken by some Prussian Uhlans between Berlin and Potsdam. Two sets of officers proceeded from Berlin to Potsdam. Each set was equipped with a complete telephone apparatus, which, together with the requisite quantity of thin wire, was carried by one of the men in a leather case on his chest. The end of the wire was, by means of a fork, fixed at the end of a lance, and thrown over the tops of the trees along the road. As each kilometre of wire was thus suspended, a halt was made to ascertain whether there was connection with the station. A new kilometre of wire was then connected with the former, and the march resumed. The two sets met at Teltow, where the wires, having been tested, were connected, and telephonic connection between Berlin and Potsdam was established. The distance is about 20 miles, and the whole task was completed in about four hours.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—October 8th. Tenders are wanted for the supply and delivery of 200 cast-iron lamp-columns, carriers, and globes for the Electric Lighting Committee. Details can be obtained at the office of Mr. T. S. Porter, clerk, Town Hall, Bedford.

Belgium.—October 10th. The municipal authorities of Tongres are inviting tenders for the concession for the public and private electric lighting of the town. Tenders are to be addressed to the Administration Communale, Tongres, Belgium.

Belgium.—October 16th. Tenders are invited for the supply of two lots of telegraph cables and copper wire for the telegraph service. Tenders to the Direction Generale des Chemins de Fer, Postes et des Telegraphes, La Bourse, Brussels.

Berlin.—October 10th. Tenders are invited for the supply of three horizontal compound steam-engines, seven tubular boilers (on the Schulz-Knaudt system), and a travelling crane, for the Berlin Municipal Waterworks. Particulars from the Bauamt der Stadtischen Wasserwerke, Neue Friedrichstrasse 69 II., Berlin.

Blackburn. — October 5th. The Corporation invite tenders for electric lighting cables and accessories.

Croydon.—October 8th. The Council invite tenders for wiring and for supplying and fixing electrical fittings at the new Town Hall, Courts, and Free Library. Particulars from Mr. Chas. Henman, 64, Cannon Street, London, E.C.

Dundalk.—October 7th. The Town Commissioners invite tenders for an electric lighting installation.

Dundalk.—The attention of our readers is drawn to the change in the official announcement of the Dundalk Town Commissioners. They at present only require the services of an electrical engineer to advise them *re* electric lighting, and to assist in obtaining a provisional order.

Edinburgh.—October 12th. Tenders are invited for the wiring of the Waverley Market, for the Lord Provost, Magistrates, and Council. Particulars from the resident electrical engineer's office, 5, Dewar Place, Edinburgh.

France.—October 10th.—Tenders are being invited for the supply of a quantity of paper-insulated cables in two lots. Tenders to be addressed to the Direction Generale des Postes et Telegraphes, 103, Rue de Grenelle, Paris.

High Wycombe. — October 14th. The Chepping Wycombe Urban Sanitary authority invite tenders for working the electric lighting provisional order obtained by them within the borough, for a term of years and upon approved conditions. Tenders to be delivered to the Town Clerk, High Wycombe, from whom further details may be obtained.

Leicester.—October 12th. Tenders are wanted for the erection, at their New Swithland reservoir pumping station, of four Lancashire boilers, each 27 feet 6 inches long and 7 feet diameter, for the Corporation of Leicester. Particulars from Mr. J. B. Everard, M.I.C.E., 6, Millstone Lane, Leicester.

London, W.—October 7th. Tenders are invited for the supply of stores from November 1st to October 31st, 1896, for the Great Western Railway Company. The following are some of the items: (9) Acids, alkalies, &c.; (10) oils, turpentine, &c.; (17) India-rubber goods; (18) telegraph instruments; (19) telegraph apparatus; (20) copper wire, G.P. wire, &c.; (21) telegraph ironwork and tools; (22) telegraph drysalteries; (23) carbons for electric light; (24) zinc, antimony, copper pipes, brass, &c.; (31) cast-iron pipes and rain-water goods; (40) tubes, iron and steel: (47) telegraph poles and yellow pine. Samples and patterns may be seen on and after 23rd inst. at the office of the Stores Superintendent, Paddington Station.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—The Municipal Authorities of Bucharest, Roumania, are at present inviting tenders for the supply of a number of electric lamps and arc light carbons required in connection with the public street electric lighting.

Southmolton (North Devon).— Tenders invited for wiring the factory buildings for the electric light and ironing, including all the electric generating plant, for the Southmolton Shirt and Collar Manufacturing Company, Limited. The company find the power. Particulars from the Secretary.

Spain.—October 8th. Tenders are being invited for the concession for the electric lighting of the town of Almodovar del Campo during a period of 20 years. Tenders to be sent to the Ayuntamiento de Almodovar del Campo (Ciudad Real).

Thetford.—October 5th. Tenders are invited for the supply of a new boiler (Cornish type), for the Town Council. Particulars from Mr. John Houchen, town clerk, Thetford. Tenders, sealed and endorsed "Thetford Waterworks, Tender for Boiler," must be delivered by October 5th.

Vienna.—November 14th. The Municipality of Vienna asks for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

CLOSED.

Bolton.—The Co-operative Society of Farnworth and Kearsley, near Bolton, have just decided upon the tenders for telephones and the whole of the work has been placed in the hands of Mr. R. S. Blackburn, of Hebden Bridge. The installation will consist of communication between the central premises in Market Street, Farnworth, and 10 outlying distant branches covering about 6½ miles of wire routes. The whole of the lines are to be of No. 12 B.W.G. copper wire, two stations on a line in series. Mr. Wooler, of Manchester, is consulting engineer for the work. We understand Mr. Blackburn has also in hand a system of telephones on the intercommunication system for the Works of Messrs. Wilson Bros., Cornholm, near Todmorden.

Tunbridge Wells.—For electrically lighting the Great Hall, Tunbridge Wells, the following tenders were sent in:—

E. Powell (accepted)	£86 18 0
Electric and General Contract Corporation* ...	80 15 3
Laing, Wharton & Down	90 15 3
Gilbert & Co.*	107 2 6
A. Wood	123 16 9
Hollingum & Saword	131 11 0
Drake & Gorham	168 19 0
S. E. Haward*	176 3 6
J. S. Cunnington & Co.	178 17 3
Tewson & Streatfield	199 7 6
Newton & Co.	198 11 5

Tenders marked thus (*) did not include the price of 120 lamps.

NOTES.

City and Guilds of London Institute.—At the recent matriculation examination of the City and Guilds Central Technical College, 76 candidates presented themselves, and 62 have been admitted to the college. The highest place was taken by M. Solomon, to whom the Clothworkers' Scholarship of £60 a year and free education has been awarded.

An assistant, with a practical knowledge of alternating current working, is wanted for the Physical Department at the Technical College. Further particulars will be found in the "Educational" announcements in our advertisement supplement.

Horseless Carriages.—Sir David Salomons has arranged for an exhibition of horseless carriages on Tuesday, October 15th, at the Tunbridge Wells Agricultural Show Ground, which has been kindly lent to him for the occasion. The carriages will enter the ring at three o'clock p.m. The grand stand is reserved for those attending by invitation. In order to offer all interested in these new carriages an opportunity to attend, the ground will be thrown open to the public on payment of 1s. entrance fee. Sir David is paying the expenses of the exhibition, and intends to employ the entrance money for prizes to be awarded at the show of the Tunbridge Wells and South Eastern Counties Agricultural Society, next year, for the best horseless carriages intended to be used for agricultural trade and private purposes. Sir David has no interest whatever in the manufacture or sale of carriages of this type, his sole object being to give practical information to the public concerning a new movement which is likely to be of immense benefit to the English nation. Invitation tickets may be secured in order of application by fellows and members of the following respective institutions sending an addressed envelope to the Secretary of the Institute of Civil Engineers, Great George Street; the Institute of Electrical Engineers, Victoria Street; the Institute of Mechanical Engineers, Victoria Chambers; the Royal College of Physicians, Pall Mall East; or the Royal College of Surgeons, Lincoln's Inn Fields. It must be understood that if applicants do not receive a reply within three days, it will not be possible to send a card.

St. Pancras and Electric Lighting.—Mr. Sydney W. Baynes, of St. Pancras, has sent to the *Times* a further letter regarding high *versus* low voltage, closing the controversy, so far as he personally is concerned. He says:—

Pressure of work makes it difficult for me to keep up a correspondence on this matter. In reply to Dr. Fleming, I gather the gist of his remarks to be that very careful inspection and testing will be found necessary. This is an essential point in any well-regulated central station, and applies equally to a five-wire high tension alternating, or high tension continuous current system. I wish to make it clear that no sweeping change of voltage is contemplated. The consumers already supplied at 110 volts will continue to receive that voltage, and it is optional for them to change if they consider the lighting obtained from the higher voltage to be more satisfactory. I have had consumers owning two sets of premises, having 230-volt lamps in one, and 115-volt in the other. After a fair trial of the two, they decided to replace the low voltage lamps with the higher voltage. It seems strange that Messrs. Handcock & Dykes, having "past experience with 220-volt installations," should have any difficulty in knowing where to procure lamps of that voltage. I regret I have not the pleasure of knowing these gentlemen, as it may be that, having an interest in the lamp making industry, they feel somewhat aggrieved at not being ready to meet the demand; but the loss has no need to be of a permanent nature, as the field is open to all. As to their invitation to repeat my experiments through the medium of an expert, much as I should like to assist my friends in their thirst for knowledge, I am not at their service in this respect. I have had close on two years' labour in this direction. Let them study the matter for a similar period, and then they will better understand the subject. What, for instance, do they mean by asking me to submit a 220-volt lamp to a total variation of 8 per cent., which is equivalent to a continual fluctuation of nearly 18 volts? No, sir, I must decline with thanks, and suggest that when central station engineers are allowed a latitude of 18 volts in the regulation, they will conclude that the millennium is not far distant. This letter closes the correspondence as far as I am concerned.

The "Iona" Disaster.—At the resumed inquiry into the cause of this disaster, the coroner, on Tuesday, asked Mr. J. F. Flannery, M.P., an expert in naval building, and consulting engineer to the owners of the vessel, if there was any possibility of the electric light being the cause of the fire. Mr. Flannery replied that fires had arisen from this cause. Mitchell Marshall, chief engineer of the *Iona*, was called with regard to the electric lighting arrangements, and testified to their efficiency. He said he never knew a fire originate from any defect of the electric fittings. As we go to press we learn that the jury found that the fire originated in the oil lamp-room.

Electrical Engineering Classes.—From the Polytechnic, Regent Street, we have received a prospectus of special courses of instruction to be given during the winter months in "Electrical Engineering and Experimental Physics," under the direction of Mr. W. Hibbert, F.I.C., A.I.E.E., assisted by Messrs. W. J. Thorrowgood and G. Cripps. The course opens on Friday, October 4th, at 8 o'clock p.m., with a lecture on "Cooking by Electricity," by Mr. Hibbert. There will be practical demonstrations by Messrs. Crompton & Co.

Electrical Matters in Japan.—A Japanese writer in the *Electrical Age* says that the utilisation of water power for the generation of electric current for street railway and other purposes is receiving considerable attention in Japan at the present time, and several undertakings of this character are now being developed. There is already one such plant in operation, and it is working very successfully. It is the street railway in Kyoto. The line is 12 miles in length, and is operated on the single trolley system. It has given such excellent results that in other cities, including Tokyo, Yokohama and Osaka, permission is being sought for building roads on the same system. The authorities of Osaka and Tokyo, however, hesitate about granting the permission desired on account of the possible damage to water pipes, which are being now laid down. The writer continues:—

Being aware of the corrosion of underground pipes in Brooklyn, Boston and other American cities, where single trolley roads are in operation, the authorities in our cities are inclined to go rather slow in permitting the use of that system, and before definite action is taken a special committee has been appointed to carefully investigate the subject of the action of stray currents upon underground pipes, and the prevention of the same. What makes it so much harder to push the single trolley enterprise in Tokyo is the efforts of another syndicate to introduce the double trolley system. This syndicate represents a capital of $1,900,000, and proposes to build 84 miles of road. Upon the settlement of the question in Tokyo the result of the agitation in other Japanese cities will much depend, and in all places everything is ready for active operations as soon as the matter is settled and the desired permission obtained. Eight mines in Japan are worked by electric power and lighted by electricity, all the generators, motors, and incandescent lamps being manufactured in Japan. Excepting a special form of telephone, and the agglomerate carbon for the Leclanché battery, all of the instruments and battery materials used in the Japanese telegraph and telephone services are manufactured and supplied by native concerns. The following statistics concerning electric lighting in the three largest cities of Japan will be of interest:—

	Population.	No. incandescent lamps, 8 C.P.	Arc lamps, 1,200 C.P.
Tokyo	1,303,876	34,436	160
Osaka	484,409	22,203	140
Kyoto	328,403	12,638	19

A preliminary survey has been made by the Japanese authorities for the laying of a submarine cable to Formosa, which is a part of the territory recently acquired by Japan as a result of the war between this country and China. The cable will be quite a long one, and will be laid down before long, a cable ship having gone to England to procure the cable. The outlook for electrical enterprise in general in this country is very favourable, and we are rapidly following in the footsteps of your great country in the use of electrical apparatus.

Chlorates and Hypochlorites by Electrolysis.—It is generally held that in the electrolysis of aqueous solutions of potassium chloride, hypochlorite is formed in the cold and chlorate when warm. Experiments, however, which were made recently by F. Oettel, showed that the hypochlorite was not the only product at ordinary room temperature, and that a small quantity of perchlorate was formed as well. Accordingly he wrote a paper in the *Zeits. f. Elektrotechnik u. Elektrochem* on this subject, and drew some conclusions, which placed him in antagonism with some of his contemporary experts. Now, there is no reason for supposing that Oettel's experiments were not accurately conducted, nor for presuming that the results did not warrant the conclusions; but we find that the experiments to which we refer were conducted with only a small proportion of caustic potash present. In a more recent paper Oettel describes another series of experiments, in which the proportion of alkali was increased, and in which it was found that the course of the reactions was modified in a quite unexpected manner. By electrolysis in strongly alkaline solutions, the chlorate is formed directly, and without the intermediate production of hypochlorite. This direct electrolytic process is clearly simple and elegant, the only practical difficulty being the expense of the platinum anodes. Oettel calculates that 88·14 grammes of potassium chlorate should be obtained per effective (electrical) horse-power per hour, or that the production of a kilogramme of chlorate would require 11⅓ effective horse-power hours.

A Russian Cartridge Factory.—The Russian Government have opened at Euganek, in the Government of Ekaterinburg, a cartridge factory capable of turning out 100,000,000 cartridges for small-bore rifles. One thousand hands are employed in the establishment, power being electrically transmitted.

Obituary.—The funeral of the late Mr. John Rowland Edwards, whose death we announced in our last issue, took place at Roby on Saturday last. Deceased, who was Postal Telegraph Superintendent for the North Wales district, was born at Bangor in 1837, and was descended from an old well-known Welsh family, the members of which have performed distinguished military and other national services. The deceased gentleman's cousin is the famous General Rowlands, V.C. In the early days of telegraphy, Mr. Edwards became connected with the Electric and International Telegraph Company, now defunct, and rendered excellent service as a pioneer of the system in Scotland and elsewhere. When the United Kingdom Telegraph Company was formed in 1860, to inaugurate a uniform shilling tariff for 20 words, Mr. Edwards joined the company, and superintended the construction of the lines from London to the important northern centres. Subsequently he took charge of the maintenance and working of the telegraph lines of the Bridgewater Canal Trust. It was not until the year 1872 that he became directly associated with the Post Office telegraph service. He then had his headquarters at Chester, and took charge of the North Wales district as superintending engineer. His administration was a model of efficiency. He was one of the most genial of men, and ever kindly and courteous to all around him. As an inventor he was likewise well known, and took an active part in the evolution and development of the great telegraph system until it attained its present almost perfect condition. His loss will be deeply felt, not only by his personal friends, but by all who had the privilege of his acquaintance.

Prevention of Collisions at Sea.—An experiment of considerable interest and importance is being made on the London, Chatham and Dover Company's steamers crossing between Dover and Calais, with a view to reducing the risk of collisions at sea in fogs at night. Some preliminary experiments were, according to the *Times*, made in the mail packet *Calais-Douvres* on Saturday night. An electric search light, of suitable make, has been fixed in the fore part of the ship, in front of the fore funnel, where the fog signals are sounded. When a blast is given on the fog whistle, the search light is used to flash a powerful vertical beam of light into the air. The difficulty in a fog is to determine what is the position of approaching vessels, and it is with this object that the experiments are being made. The system is the outcome chiefly of the observations of Captain Dane, an experienced commander in the service, who is also directing his attention to devising a system of day signalling. The other steamers are to be fitted with the light.

Sewage Pumping by Electricity.—A scheme was recently proposed by Mr. H. South for pumping sewage by electricity at Sunbury-on-Thames. The Council's engineer, Mr. Anstie, has reported upon the scheme, dealing with each detail supplied by Mr. South. He points out that whereas Mr. South has estimated £5,000 for the electrical machinery, against £7,860 for his, Mr. Anstie's scheme, there had been omitted several items, which would bring it up to £6,244. He considered the annual outlay in connection with the electrical scheme would prove fully as expensive as the ejector scheme, and Mr. Anstie questioned whether the Council were justified in trying the experiment in such an important district. He further gave his opinion that the Local Government Board would not sanction the expenditure on the electric scheme in lieu of the one they had already sanctioned. The matter is to be further considered at the next meeting.

Electrical Progress in Canada.—On the occasion of a banquet to the delegates of the Canadian Electrical Association, at Ottawa, on 18th ult., there were most elaborate electrical decorations. The speech of the evening was delivered by Mr. George Johnson, who spoke of the advancement in electricity since 1837, and showed that in Canada alone $27,000,000 was invested in railways and electrical appliances. The Dominion had 368 miles of electric railway line, while in all Europe there were only 428 miles of electric railway service. The Canadian electric railways last year carried 57,000,000 people, while the steam railways in Canada only carried 14,000,000 people.

Gold Extraction.—As a solvent for gold when precipitating this metal by electrolysis, Dr. Gaze makes use of "chloride of bromine," as it is termed [*vide* "Eng. and Min.," j. lix. (1895), p. 442]. We are afraid that the *doyens* of the Chemical Society would hardly admit this nomenclature; however, we can see what is meant by following the process through. Vessels containing mixed chloride and bromide of sodium solutions, and carbon rods, are arranged, and in these are placed porous cells containing water, in which are also immersed carbon rods. The containing vessel is fitted with a lid. One set of carbons is connected with one pole of a dynamo, and the other with the other pole. The salts are decomposed by a strong electric current; the chlorine and bromine "unite to form chloride of bromine," which is then forced up into a vessel above. Thence it runs on to the crushed gold ore in an air-tight vat; air is forced in at a pressure of 50 lbs. per square inch. The whole is left for two hours, in which time the gold all becomes dissolved. The solution is filtered off again and used with fresh ore until it becomes either rich in gold or weak in solvent power, when it is electrolytically decomposed into gold and "chloro-bromic acid." The solvent seems to split up in course of time, as the solution becomes charged with hydrochloric and hydrobromic acids. These acids are neutralised with caustic soda, producing the original salts, which are again used for producing the solvent.

Electric Soldering.—In a recent issue of *L'Industrie Electrique*, pp. 359—361, attention is directed to a new process of electric soldering, which is due to Dr. Zerener, of Berlin, and is being exploited in France by MM. Womes and Zwierschowski. It appears that the electrical principle for adding metals is almost a novelty in France, although for some time now it has been recognised as practicable, and used accordingly in this country and in America, the processes of Thomson, de Benardos and Lagrange-Hoho being perhaps the best known. The writer in *L'Industrie Electrique*, Mons. Garnier, passes in review the various advantages and disadvantages of the systems which have hitherto been used, and claims that the Zerener's method is superior to them all. He utilises the heat of an electric arc, the arc being produced not between a carbon pencil and the object to be soldered, but between two carbon pencils, as in the ordinary arc lamp. It is claimed that this plan enables the current to be regulated accurately, and prevents the use of currents of too great an intensity. The two pencils are arranged in a handy apparatus in a V-shaped position, whilst the arc plays in a magnetic field produced by an electro-magnet, and is such that it is always kept turned towards the point of the V. Thus the flame of the arc takes the form of an arrow-head, and as such is easily utilised for soldering purposes. The apparatus can be used either with a continuous or an alternating current. The details can be seen in the original paper, where it is fully described and illustrated with blocks.

Tourist Guides.—We have received a set of the "Darlington" illustrated handbooks for tourists, edited by Ralph Darlington, F.R.G.S. They deal with the North Wales Coast, Jersey, Guernsey, Alderney and Sark, Bournemouth and the New Forest, the Isle of Wight, the Vale of Llangollen, Aberystwyth, Towyn, Barmouth and Dolgelly. Each book is provided with a map by John Bartholomew, F.R.G.S., and a number of photographic and other views. Our own opinion is that visitors to any of these districts should have one of these guides in their possession.

Electric Elevator for Boats.—An elevator worked by electric power has recently been built for the Ottawa Canoe Club, Ottawa, Ont. Owing to the great rise of the Ottawa River every spring, the boat house is situated a good height above the water level the greater part of the year. The transfer of the boats from the house to the water, and *vice versâ*, was thus extremely difficult, and to obviate these drawbacks there has been erected a framed gangway, with a skeleton car, an ordinary worm-geared hoisting drum, and a 3-kw. 500-volt Edison motor. The motor is belted to a countershaft, that is in turn belted to the shaft carrying the worm. The car stops automatically at the top and bottom of the allotted course. Mr. Dion, of the Ottawa Electric Company, and reasurer of the club, designed the arrangement.

New Photographs of Lightning.—The following note by M. N. Piltschikoff was presented by M. Mascart to a meeting of the Académie des Sciences on May 26th last. "I photographed, under rather favourable conditions, several flashes of lightning during the storm that passed over Odessa from S.W. to N.E. I have the honour to present to the Académie three typical photographs of lightning, which might be designated by the names of ribbon lightning, tube lightning and waterspout lightning. I have met with the two first types of lightning (ribbon and tube) in all storms, whereas I have only obtained waterspout lightning once, on May 26th. The ribbon lightning is shown on the photograph in the form of a ribbon with many folds, but untwisted. The actual width of the luminous band, according to the proof obtained with an *extra rapid Dallmeyer objective*, No. 57,383, exceeds 12·5 metres. The ribbon comes out of a cloud, grows faint, and fades away into space, without its being possible to distinguish the last part of its course. During another storm at Odessa, on June 13th, a luminous ribbon had a width of ·75 mm. on the plate; as the lightning was flashing at a distance of over 10 km., its width was really more than 62 m. Another ribbon flash (storm at Kharkow, July 2nd, 1891) was at least 21 m. wide. The second photograph represents a flash of tube lightning. The lateral surface of the tube appears to be very similar to that of fulgurites, with the same contractions and the same changes of direction. The diameter of the tube is about 15 m. In the storm observed at Kharkow a flash of tube lightning was 21 metres wide. The third type presents itself in a form greatly resembling a waterspout. Is this a mere chance resemblance, or does it result from a general cause, a gyration causing the masses of damp and rarefied air to rise and fall? I will not venture to express an opinion on this obscure but interesting point in electrical meteorology. The question of the inner nature of lightning is not easily solved. The opinion often put forward that the disruptive discharges of our sources of electricity are in all points similar, setting aside the dimensions to read flashes of lightning, is perhaps somewhat rash. Can we obtain with electrostatic machines, or with electric currents of a high potential and high frequency, discharges in the form of a ribbon, tube or waterspout? I have tried the experiment without success. On several of my photographs we can see, simultaneously with the flashes of ribbon lightning, very fine lines of lightning, which shows decisively that the form of ribbon lightning is absolutely independent of the chance displacements of the photographic apparatus. This form of lightning should have an interesting relation to the draperies of the aurora borealis."—*L'Industrie Electrique.*

Dangers of Electric Lighting.—A special Paris correspondent of the *British Medical Journal* says that the numerous deaths among the staffs employed in the electrical lighting works has attracted the attention of the Minister of Public Works, who has asked the Paris Medical Academy to draw up directions concerning the treatment of those injured by contact with the wires, and also concerning the technical precautions to be taken. The medical treatment formulated by the Academy is the same for injury from electrical shock, no matter what is the nature of the current inflicting the injury. But the technical precautions differ according to the nature of the current. If the person injured remains in contact with the electrical conductors, the assistant who extricates the injured must be careful before commencing operations to have dry hands and wear a pair of thick flannel or stuff gloves, and not to take hold of the injured person by a region in perspiration. In non-interrupted currents the electrical conducting wires must not be cut. When the wire is cut, it must be cut in two places. The medical treatment consists of placing the injured person where there is plenty of air, loosening the clothes, rhythmic traction of the tongue, rubbing the body, &c. M. Dupuy Dutemps has forwarded these directions to the Prefects, urging them to make them known especially among engineers and staff of the Ponts et Chaussées entrusted with the electrical lighting of streets, to the directors of electrical stations, municipal authorities, medical men, and dispensing chemists. The instructions corresponding to the respective currents will be pasted on the wooden structures to which the poles are fixed.

School of Languages.—We hear that in addition to the Central School of Foreign Tongues at Arundel Street, Temple, E.C., Mr. Howard Swan has just opened a new school for boys and girls to introduce the Gouin methods of teaching into earlier education, at the New School, Bedford Park, W.

NEW COMPANIES REGISTERED.

Round's Accumulator Company, Limited (45,288).—This company was registered on September 17th with a capital of £10,000, in £1 shares, to enter into a certain agreement, and to carry on business as electricians, electrical contractors, mechanical engineers and suppliers of compressed air and electricity. The subscribers (with one share each) are: J. Leah, 8, Denmark Street, Barking Road, E., engineer; W. J. Warrilow, 45, St. George's Avenue, Upton, E., gentleman; J. K. Frost, Crooked Billet, Barking, gentleman; J. Stafford, 17, North Woolwich Road, E., cooper; E. Woolmer, 38, Hermit Road, Canning Town, gentleman; M. Round, 124, West Ham Lane, E., tailor; F. P. Bunt, 252, Barking Road, E., manufacturer. The number of directors is not to be less than three, nor more than nine; the subscribers are to appoint the first. Qualification 200 shares; remuneration £100 each per annum, and £25 extra for the chairman. Registered by C. H. Yell, 72, Grange Road, Plaistow, E.

Crystal Electric Lamp Company, Limited (45,280)—This company was registered on September 17th with a capital of £15,000 in £5 shares, to enter into an agreement with J. W. Rogers, and to carry on the business of electricians, electric lamp manufacturers, engineers, &c., and the business of an electric light company. The subscribers (with one share each) are:—J. W. Rogers, 7, Hargrave Park, Highgate, electrical engineer; F. Naylor, St. Stephen's Chambers, E.C., solicitor; H. J. Gibbs, Tentercroft, Streatham, merchant; J. Wiggins, St. Stephen's Chambers, E.C., solicitor; J. H. Smeed, 105, Bouverie Road, N., gentleman; W. W. Smith, 4, Northbrook Road, Lee, merchant; G. Hawkins, 35, New Cross Road, S.E., builder. The number of directors is not to be less than two nor more than five; the first are:—J. W. Rogers, H. J. Gibbs, and F. Naylor. Qualification, £500; remuneration, £50 per annum, and a share in the profits divisible. Registered office, St. Stephen's Chambers, Telegraph Street, E.C.

Lithanode Electric Storage Company, Limited (45,354).—This company was registered on September 23rd with a capital of £12,000, in £1 shares, to acquire the business carried on by the Lithanode and General Electric Lighting Company, Limited, at 64, Millbank Street, Westminster, to adopt certain agreements, and to carry on the business of an electric, gas, and other lighting company. The subscribers (with one share each) are:—E. G. Dakin, 18, Longley Street, Southwark, clerk; J. H. Matthews, 4, Kirby Street, E.C., clerk; F. Stuttaford, Worcester Park, Surrey, solicitor; H. W. Roach, 50, Gladsmuir Road, Highgate, accountant; R. A. Dawson, 46, St. George's Road, Forest Gate, clerk; W. J. Cooling, Morland Road, Croydon, clerk; W. R. Elston, 84, Olney Street, S.E., clerk. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, £50; remuneration, two guineas each per board meeting attended, and a share in the profits. Registered by Reynolds, Blogg & Co., Union Court, Old Broad Street, E.C.

Universal Electric Carriage Syndicate, Limited (45,378).—This company was registered on September 25th with a capital of £5,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, and manufacturers and owners of electrical vehicles, and carriages, and workers of and dealers in electricity. The subscribers (with one share each) are:—D. C. Miller, The Lindens, Croydon, J.P.; C. N. Stewart, 39, Victoria Street, S.W., engineer; R. J. Hinton, Bramley Hill, Croydon, merchant; W. C. Bersey, Grosvenor House, South Hackney, electrical engineer; G. E. Thompson, 13, Woronzow Road, N.W., printer; R. Wheeler, 4, Chatsworth Road, Croydon, agent; R. H. Wheeler, 5 and 6, Billiter Avenue, E.C., accountant. The number of directors is to be four; the first are the first four subscribers; remuneration 10s. 6d. each per board meeting attended. Registered by G. A. King, 66, Cannon Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Globe Telegraph and Trust, Limited (7,465).—This company's annual return was filed on August 16th. 180,042 preference and 180,227 ordinary shares have been taken up out of a capital of £5,000,000 in £10 shares (of which half are preference), and the full amount has been called and paid.

Cellini Art Metal Works, Limited (45,219).—This company was registered on September 11th, with a capital of £5,000, in £5 shares, to manufacture, sell, and deal in art metal work, chandeliers, brackets, standards, hall lamps, electroliers, church fittings, suspension lamps, &c., for gas, electric light, and oil. Registered without articles of association. Registered office, Great Cornbow, Halesowen.

Exchange Telegraph Company, Limited (6,152).—This company's annual return was filed on August 20th. 8,125 "A" and 16,200 "B" shares have been taken up out of a capital of £246,250 in 8,125 "A" and 16,500 "B" £10 shares. The "B" are all issued as paid, and £8 per share is considered as paid on 2,125 "A." £9 per share has been called on 6,000 "A" and £1 per share on the remaining 2,125 "A." £56,023 is paid, and £102 unpaid.

Manchester Edison-Swan Company, Limited (16,847).—This company's annual return was filed on August 16th. The capital is divided into two parts, one £450,000, in "A" shares of £9 each, and £100,000 in "B" shares of £10 each; 20,000 "A" and all the "B" have been taken up, and 30s. per share has been called on the "A." and the full amount on the "B;" £129,931 5s. has been paid, and £65 15s. is in arrears.

Electrical Power Storage Company, Limited (30,313).—This company's annual return was filed on August 20th. The capital is £100,500, in £5 shares (100 founders'). 18,257 ordinary and 66 founders' have been taken up, and 15,120 ordinary have been issued as fully paid. £5 per share has been called on the founders' and £3 on the ordinary, and £9,617 2s. 8d. has been paid, leaving £123 17s. 4d. unpaid.

Electricity Supply Company for Spain, Limited (29,103).—This company's annual return has just been filed, when the capital of £100,000, in £5 shares (100 founders') was all taken up. The founders' shares have been considered as paid, and the full amount has been called and paid on the rest.

Electrical Company, Limited (36,819).—This company's annual return has just been filed. The 3,000 shares of £5 each, which comprise the capital, have been issued with £3 per share considered as paid, and £1 per share has been called and paid on each as well.

Shropshire Electric Light and Power Company, Limited (33,262).—The company's annual return for 1894 and 1895 were filed on August 31st and 29th respectively. The capital is £25,100 in 2,500 £10 and 100 £1 shares; 275 ordinary or £10, and 44 founders' or £1 shares, have been taken up, and £2 5s. per share has been called on the ordinary and nothing on the others. £596 5s. has been paid, leaving £22 10s. unpaid.

Electrical Oil Refining Company, Limited (45,126).—This company's statutory return was filed on August 23rd. Out of a capital of £5,000 in £1 shares, 2,000 have been taken up, and 1,493 have been considered as paid. £1 per share has been called on the rest, and £500 has been paid, leaving £7 unpaid.

Electric Motive Power Company, Limited (41,132).—This company's annual return has just been filed. The capital is £20,000 in £1 shares (10,350 preference). 9,650 ordinary have been issued as fully paid. 754 preference shares have been taken up, the full amount called, and £747 paid, leaving £7 unpaid.

Hobart Electric Tramway, Limited (35,926).—The annual return of this undertaking has just been filed; 45,000 shares have been taken up out of a capital of £105,000, in £1 shares, and 20,000 have been issued as fully-paid. The full amount has been called and paid on the rest.

Exeter Electric Light Company, Limited (26,059).—This company's annual return was filed on September 12th. The capital is £20,000, in £10 shares (500 "A" or preference); 1,125 ordinary and 75 preference have been taken up, and 305 ordinary issued as fully-paid. The full amount of £8,950 has been paid on the remainder.

F. H. Royce & Co., Limited (41,362).—This company's annual return has just been filed; 15,103 shares have been taken up out of a capital of £30,500, in £1 shares (500 deferred), and 12,514 have been issued as fully-paid. The full amount has been called on the rest, and paid in full, with the exception of £5.

Lancashire Electric and Engineering Company, Limited (27,661).—As the business of the above-named concern has been sold to another company, the returns have not been filed, and the name of the company will be struck off the Register in the near future.

Thomas Parker, Limited (40,973).—The annual return of this company was filed on August 16th. 5,087 shares have been taken up out of a capital of £75,000 in £10 shares, and 1,750 were issued as paid. £8 per share has been called and paid on the remaining 3,337 shares.

Harrow Electric Light and Power Company, Limited (44,529).—The registered office of this company is now situate at 9 New Inn, Strand, London, W.C.

Telautograph Company, Limited (43,773).—This company's annual return was filed on September 11th. The capital is £42,000 in £1 shares (6,000 preference), 8,492 preference shares taken up, and 10s. called on 8,485 shares. £4,217 10s. has been paid, leaving £25 in arrears. No calls have been made on the other seven shares.

Babcock & Wilcox, Limited (34,289).—This company's annual return was filed on September 25th. The capital is £240,000 in £10 shares (10,000 preference). All the shares have been taken up, and 3,333 preference and 4,666 ordinary issued as paid. Full amount called on the remainder, and £160,010 paid.

Walsall Electrical Company, Limited (37,696).—This company's annual return was filed on September 21st; 683 shares have been taken up out of a capital of £10,000, in £10 shares; 200 have been issued as paid, and £4,830 has been received in cash.

CITY NOTES.

Froggatt's Electric Lighting Company, Limited.

The first annual meeting of this company was held on Monday, at Winchester House, E.C.

Mr. A. De Murrietta (the Chairman), in the course of his remarks, said they regretted that the statement submitted was not more favourable. In all new businesses, however, the first year was a very difficult one, and in their own case it had been full of difficulties, especially as regarded the lighting of public vehicles—a branch to which they had specially devoted themselves. However, after the experience they had gained, they felt confident now of overcoming all obstacles, and under contracts for the London Tramways Company they were lighting cars with over 500 lights, for the Glasgow Corporation over 800 lights, as well as many omnibuses for Balls Bros., Tilling's, &c. They had also sold apparatus for lighting six omnibuses for the Isle of Man Electrical Tramways Company, who are trying the company's system. The extension of this business, however, required serious consideration, owing to the large amount of capital it absorbed, the rough treatment their batteries were exposed to, and the large number of men they were obliged to employ for night work, and particularly in bad weather. This difficulty, however, had been got over in the case of the London Tramway Company, whose own staff now attended to this work, and they hoped to make a similar arrangement with the Glasgow Corporation. The revenue from advertisements on their lighting discs had been disappointing. He thought this branch would be more satisfactory in future. Since the date of the report they had secured large contracts for advertisements. They were now devoting more attention to portable lights for houses, cycles, travelling lamps and policemen's and postmen's lamps. Another very important field for lighting had been started by them, but it was not advisable to refer to it in detail. He might, however, mention that an influential firm connected with this field had been much impressed with what they had already done, and had approached them with a view of acquiring the agency, and carrying out the scheme. A considerable amount of friction and disagreement had arisen on several occasions between the directors themselves and between the board and the manager, and in these circumstances they thought it advisable that the shareholders should appoint a committee to confer with the directors with a view of reorganising the board and management generally.

Mr. M'Gill seconded the motion, which was carried.

Mr. Diamond (a shareholder) seemed desirous of raising discussion regarding the disagreements and friction referred to by the chairman; he thought the meeting could at once appoint the suggested committee without calling them all together again; but all his attempts were useless, the only satisfaction he could obtain was a promise from the directors that a meeting should be called in about a month to appoint the committee.

The Legal Adviser to the company having moved a vote of thanks to the chairman, the meeting closed.

Willans & Robinson, Limited.

The third half-yearly report of the directors, to be submitted at the ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, London, at three p.m., on Tuesday, October 8th, 1895, states that the engine orders in the half-year amounted to 12,832 indicated horse-power, against 10,315 in the corresponding half of 1894, and 9,290 in that of 1893 (old company). As previously pointed out, the company has great difficulty in keeping pace with its orders, and the fast increasing demand for the Willans engine, though encouraging for the future, is only a source of embarrassment in the present, and must continue to be so until the new works at Rugby are completed. Notwithstanding this serious drawback, the result of the half-year's work is satisfactory. After writing off as depreciation from plant, patents, &c., the large sum of £3,762 0s. 3d. (exceeding by nearly £900 the liberal amount written off last half-year), the balance to the credit of profit and loss account for the half-year is £10,614 2s. 7d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum (as before) upon the ordinary shares, together amounting to £6,586 5s. 2d. The amount payable to the directors, in accordance with the articles of association, is £1,208 7s. 3d., and it is proposed to carry £2,500 to the reserve fund, raising the latter to £5,146 9s. 11d. The balance £319 10s. 2d., it is proposed to carry forward. Arrangements for the manufacture of the Willans engine upon the Continent, under license, have made further progress. "Royalties receivable" appear for the first time in the accounts, and this source of revenue is likely to increase. Licenses for certain countries have been granted upon satisfactory royalty rates, and in connection with these licenses certain sums down have also been received. After writing off all expenditure incurred in arranging the licenses, the sum of £3,632 12s. 1d. remains to the credit of profit and loss, enabling the directors, as already stated, to write off about £900 as increased depreciation, and to reserve an equal amount in the valuing of other accounts. They are also able to carry an unusually large sum to the reserve fund. The balance of the shares authorised to be issued (to which the attention of shareholders was called by circular, dated June 1st last) has been taken up. The applications for shares considerably exceeded the number to be allotted. The entire debenture debt, amounting to £9,910, was paid off as from March 31st last. Many of the debenture holders applied for and were allotted shares in lieu of the cancelled debentures. It was thought desirable to perpetuate, as nearly as might be, the system of workmen's debentures which has been for some years in force, and workmen's bonds to the amount of £1,080 were issued to the holders of cancelled workmen's debentures, bearing the same interest as the latter. The increase under salaries is chiefly due to a change in the mode of paying certain officers of the company, by which they appear in the salary list instead of in the wages list. The change has no effect upon the final result. The new works at Rugby make satisfactory progress, though they cannot commence to add much, if anything, to the out-turn from the company's workshops for another six months. Up to the present time contracts for buildings, &c. have been placed to the amount of about £18,700.

Birmingham Electric Supply Company, Limited.—At the last annual meeting of this company, it was resolved to increase the capital by £100,000, divided into 20,000 shares of £5 each, to meet the extended operations of the company in Edgbaston, and the jewellery quarter. The directors are of opinion that half the new capital should be offered for public subscription at a premium of 5s. per share, the new shares to be offered first to the present shareholders in the proportion of one new share for every two existing shares.

Isle of Man Tramways and Electric Power Company, Limited.—The directors have declared an interim dividend for the six months ending June 30th at the rate of 6 per cent. per annum on the preference shares, and at the rate of 7½ per cent. on the ordinary shares. During the months of May, June, July, August and September, the company have carried nearly half a million passengers.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 2s. per share, free of income-tax, being at the rate of 2 per cent. per annum for the quarter ending September 30th, 1895, such dividend to be payable on and after the 24th inst.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to appoint a special settling-day in, and to grant a quotation to:—Central London Railway Company: 9,104 shares of £10 each, fully-paid; 207,649 shares of £10 each, £2 paid.

Globe Telegraph and Trust Company, Limited.—The directors have declared an interim dividend of 3s. on the preference shares, less income tax, and of 1s. 3d. on the ordinary shares, income tax already deducted.

Eastern Extension Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended June 30th of 2s. 6d. per share, free of income-tax.

Reuter's Telegram Company, Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum for the half-year ending June 30th.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 29th, 1895, amounted to £823: week ending September 30th, 1894, £881; decrease, £58; total receipts for half-year, 1895, £10,971 corresponding period, 1894, £11,119; decrease, £148.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of September, 1895, amounted to £2,072, against £1,898 in the corresponding period of last year.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending September 29th, 1895, amounted to £1,266; corresponding week last year, £988; increase, £278.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 27th, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,249.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Sep. 25th.	Closing Quotation Oct. 2nd.	Business done during week ended Oct. 2nd, 1895. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,912,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	48 — 50	48 — 50	50	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	89 — 90	89 — 90	90	89¼
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	8½— 9	8½— 9	8⅝	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6¼% §	6¼% §	...	14 — 14½	14 — 14½	14 5/16	14¼
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906 ...	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3½ — 4	3½— 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —165	no quotation	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	13⅜	13¼
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9¾— 10¼	9½— 10 xd	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106 %	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	9 — 9½	9 — 9½	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	17⅛— 17⅜	17⅛— 17⅜	17⅜	17 3/16
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	18 — 18½	18 — 18½	18⅜	18¼
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	106 —109	107 —110	...	...
1,297,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	129 —132	129 —132	131½	129
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18 — 18¼	18 — 18½	18⅝	...
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106	103 —107	105½	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106	104 —107	105½	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	128 —131	128 —131	129	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106	103 —107	...	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	104 —107	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	107 —110	108 —111	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	113 —116	114 —117%	115⅜	115½
180,227	Globe Telegraph and Trust, Ltd.	10	4⅛% §	4⅛% §	4⅛%	10½— 10⅜	10⅛— 10⅜	10⅜	10⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17 — 17½	17 — 17½	17 1/16	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21⅜— 22¼	21⅜— 22¼	...	...
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	50 — 53	50 — 53	52	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	104 —108	105 —109	..	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	...	...	...	... ...	2 — 2½	2⅛	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6⅛— 6⅜	6⅛— 6⅜	6 5/16	6⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	16½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅛— 6⅜	6⅛— 6⅛	6 7/16	6¼
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	106 —108	106⅞	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	0 1/16— 1/8	0 1/16— 1/8	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 —111	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	4 — 5	5 — 6	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	128 —133	131	130½
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2⅜— 3¼	2⅜— 3¼	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	93 — 98	93 — 98	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	...	...	*nil*	5½— 6½	5½— 6½	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2	1½— 2	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	100 —105	101	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10 — 10½	10 — 10½	10	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 7	...	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4 — 4½	4 — 4½	...	...
165,200*l*	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	102 —106	103 —107	...	...
206,400*l*	Do. do. do. do "B," do.	100	6 %	6 %	6 %	102 —106	103 —107	...	..
88,321	West India and Panama Teleg., Ltd.	10	½%	½%	½%	⅜— 1	⅜— 1	1/2	7/8
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10½— 10⅝	10⅛— 10⅜	10⅜	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9½	8½— 9½	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	110 —113	110 —113	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5¼— 5⅜	5¼— 5⅜	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	7 — 7¼	7 — 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116—119	116 — 119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13⅞— 14½	13 — 14	14 1/16	14
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	14½— 15½	14½— 15½	15⅝	15
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	133 —137	135⅜	135½
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½— 9⅛	8½— 9⅛	9¼	9⅛
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	6⅞— 7¼	6⅞— 7¼	7⅛	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅛— 8⅛	7⅛— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	12 — 12½	11⅞— 12¼	12 3/16	11⅞
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —119	117 —119	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½— 9⅛	8½— 9⅛	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8½— 8⅝	8 — 8½	8½	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 9¼	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8⅝— 9¼	8½— 9	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Sept. 25th.	Closing Quotation, Oct. 2nd.	Business done during week ended Oct. 2nd, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 %§	6 %§	...	1½ — 1¾	1½ — 1¾	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %§	6 %§	...	1⅞ — 2⅛	1⅞ — 2⅛	2⅛	2
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	111 —114	112 —115	113¾	...
630,000*l*	City and South London Railway	Stock	⅝%	⅝%	1¼%	38 — 40	38 — 40	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 %§	7 %§	...	1 — 2	1 — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	2 — 2½	2 — 2½xd	...	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	⅝ — ⅞	⅝ — ⅞	⅞	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2¼ — 2⅜	2 — 2¼xd	2¼	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¾ — 1	¾ — 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝ — 1⅛	⅝ — 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½ — ⅝	½ — ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	12½ — 13	12½ — 13	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15 — 16	15½ — 16½xd	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock		...	...	104 —107	104 —107	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 21	19 — 21	19¾	...
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	103 —102xd	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	11⅝ — 11⅞	12⅛ —12⅜	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15 — 15½	15 — 15½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44½	43⅝
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	..
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4½ — 4¾	4½ — 4¾	4⅞	4 1/16

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%§; 1890—8% §.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 95—100.

House-to-House Company (£5 paid), 4¼—4⅜.

Do. do. 7 % Preference, of £5, 8—8½.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 8—8½; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 7⅞—8¼.

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6¾—7¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

GAS AND OIL ENGINES.

Whilst electricians are naturally all in favour of extending the use of electrical apparatus in the sub-division of power in large and extensive works, it is just as well they should know what is being done with other forms of power producers or transmitters. *Cassier's Magazine* has an article on the question, inspired by a recent gas and oil evening at the American Society of Mechanical Engineers.

It is but a few years since the gas engine was introduced, not much more than 20, and it was hardly expected ever to compete with steam engines, yet we can scarcely doubt now that the oil engine will soon be as reliable as the gas engine. It is already claimed to be reliable, but engineers who have had experience with oil engines know that it is apt to be troublesome. There is a difficulty in securing the correct temperature in the vaporiser, a word by the way which our contemporary somewhat pedantically spells "vapouriser," as it also spells "governour" on the same plan. If, however, these spellings indicate an American revolt against the barbaric methods of spelling so much in vogue in America, and which altogether destroy the literary and historic value of the language, we will gladly not complain.

With light loads especially there is apt to be trouble with the oil engine, and Mr. Wildy, who represented the oil engine interest at the meeting in question admitted that nursing was required at low powers, and we believe that there is a good deal of truth in this, and that oil engines as now made are not capable of running under a varying load without attention, because at light loads the vaporiser becomes too cold, and at full load is apt to get too hot. What is wanted is some means of automatically arranging a radiation guard upon the vaporiser, to be opened or shut according to the load on the engine. Mr. Wildy doubted the sanity of any man who ran an oil engine lightly loaded for many hours together, but what are we to say of this in those cases where the power required is less than sufficient to load the smallest size of oil engine that is made. Mr. Wildy is himself connected with a firm whose smallest engine is too large in this sense for many places where it could otherwise be usefully employed, and it is sheer nonsense to call on an engine user to put an absorption brake on the engine so as to get the heat necessary to ensure running. The user wants to save oil, not to consume it in this unscientific manner. So far as dividing the power in a large works is carried out by division of the steam power, there is division almost or quite as wasteful as though shafting were still employed, small engines being so exceedingly wasteful. It is bad policy to divide the boilers, and equally bad to carry steam long distances, and undoubtedly the gas engine, worked from a central gas producer, should be found very suitable as a means of dividing power.

Mr. Reeve, in pointing out the advantages of gas engines for sub-dividing power, drew attention to the waste which accrues with large steam plants. With a gas plant there is not the same loss if the holder is of sufficient size, for the gas generator works the day through at one steady pace, and the holder furnishes extra gas to get over the peaks, and stores gas during periods of idleness. In this respect, if the gas engines in each department are suited to their duty, the economy should be good, and the oil engine should stand really in a better position in countries where oil is not sold at such prohibitive prices as in England, for the storage of energy in the oil plant calls for very little room as compared with gas storage. Mr. Reeves does not consider that power transmission by electricity, air or water, can be compared with that by gas, and he specially points out that gas has a great advantage where heat also is required, as in most manufacturing establishments, for boiling, cleaning, dyeing, or sizing and drying. It is this need for some amount of heat that has kept alive the steam engine in New England,

where water could find all the power, for steam had to be produced for other purposes. The gas engine has thus a fine field, and no doubt will find great employment, but there will always be a field for electrical transmission where the smallness of the conductors and their greater safety give them preference over gas mains, but even then the gas engine will be at the central station driving dynamos, and to our mind an ideal power transmission will consist of a gas producer, with holder and electrical transmission, and possibly where there is a high peak of considerable duration in the load curve an oil engine to tide this period over, so as to avoid excessive gas storage.

Just as steam has held its own against water-power because of the call for heat, so will electricity be greatly assisted by the need for light, and the uniform working of an electrical plant will, be helped if good accumulators are used to furnish the light as they can be charged during hours of light load. This question of light is, of course, an assistance to the gas engine, if people will only face the incandescence gas burner, which will, says one man, give light equally well with producer gas as with a self-incandescent gas, but Mr. P. Winand denies this. We should not think, however, seriously of this gas light in comparison with the electric light, and as electrical mains must be laid, the transmission of power, as Mr. Reeves states, follows naturally, and any other possible arguments again lose their point. But with gas at the centre and electricity as the means of transmission, there is nothing lacking either in power, light or heat, and where water is required warm or hot, there is at once removed from the gas engine its chief loss, viz., the heat imparted to the jacket is recoverable in the warm water.

The gas engine, however, is stated to be mechanically still a crudity. It is heavy for its power, and its regulation is based on the introduction of a fault, to wit, a certain irregularity in rotation which even the best governor cannot alter. Obviously a gas engine which has 100 explosions per minute for 200 revolutions must, if it begins to overrun, drop at least one explosion, and the regularity of rotation will be dependent upon the fly-wheel energy. But after all is said, gas engines at central stations can have no serious fault where merely power is to be transmitted, and their use at several electric light stations seems to point to their satisfactory use in such, an example illustrated being the Midland Railway lighting station at Leicester.

We do not in England appear to have noticed the preference for vertical cylinders in gas engines that is said to obtain in America.

Rotary gas engines are hinted at by Prof. Aldrich, who indicates the Pelton wheel as somewhat of the lines such an engine should follow. If such could be arranged, we might expect to see great economy of gas following upon possible abolition of water jackets.

It appears that a 16-H.P. oil engine uses ·8 of a pint of oil per hour, and that in Russia oil engines are doing very well. Oil engine makers ought, in their own interest, to make known what oils will satisfactorily lubricate their engines. We know, as a fact, that oils that work well in a gas engine, are useless in an oil engine, and if oil engines are to be satisfactory, their users ought to have very clear instructions on this point.

Mr. Paul Winand prefers the gasoline to the oil engine, and to them he says the small American demand for oil engines is due, and he refers to the difficulty with the temperature of the underloaded oil engine. It is to be noted that one Brayton, an American, patented and built the first oil engine; but to Europeans the development is due. The Brayton engine only utilised 6 per cent. of the heat generated, but the modern engine utilises 20 per cent., and uses less than 1 lb. per I.H.P. hour.

It is noted that Beau de Rochas, who described the so-called Otto cycle before Otto re-invented it, probably from De Rochas's description, advised compression being carried to the self-ignition point. This is really done in the Hornsby-Akroyd and similar engines, and is not difficult to contrive. The difficulty is in its timing, which must be just at the dead point. A timing valve is inadmissible, because of the temperature, and explosion must be timed by proper choice of capacity of vaporiser and cylinder.

The piston compresses the air charge backward into the vaporiser where it mixes with the oil vapour, and at the correct mixture and pressure the explosion occurs. Pure air is next the piston, and protects this from tar, and analyses prove that the completeness of combustion secured is very good. On the whole, the oil engine is making a very good showing, and before long may be as reliable as a gas engine. For country houses it undoubtedly stands an easy first for electrical driving, as gas is not available in many places, and, where available, is often in the hands of water companies, who may object to supply gas for such purposes as pumping a private water supply, indeed we have known this consideration to lead to an oil engine being preferred. But, as already stated, there is a demand for small oil engines, and the small engine is like a baby—soon at fever heat and soon cool again. It lacks stability, and seems to defy the most careful attention and to defeat all attempts to control it at light loads. That the fault is simply one of temperature can be proved at once by adding a brake and putting on weight, until at last the load is sufficient to consume sufficient oil to give suitable temperature. But it cannot be argued that this is good practice, and there must be some means of arranging a vaporiser so that at all loads the engine will run and govern itself properly and not demand nursing. When properly working an oil engine is really a fine illustration of what mechanical engineers can accomplish.

AN ELECTRIC PRESSURE SOUND FOR THE DIRECT VIBRATION OF THE MEMBRANA TYMPANI.*

By JOHN C. LESTER, A.M., M.D.

The value of vibratory massage in the treatment of diseases, especially the atropic, of the upper air passages, has been fully attested by many careful observers of recent date. Dr. Michael Braun,† of Trieste, in a paper read before the International Medical Congress at Berlin, was the first to call attention to the value of massage in diseases of the naso-pharynx.

Dr. Carl Laker‡ has also written an exhaustive monograph on the same subject, in which he enthusiastically indorses this method of treatment. To Dr. W. Freudenthal,§ of New York City, perhaps more than to any other, is due the honour of having devised an electrical instrument for massage in diseases of the nose and throat. More recently Dr. G. Melville Black,‖ of Denver, calls attention to the value of lateral vibratory massage in diseases of the nasal mucous membrane. Possibly the inspiration of all these writers on the value of massage in naso-pharyngeal diseases was received from an investigator no less distinguished in another field—Dr. August Lucae.¶ In an article on "A New Method for the Mechanical Treatment of Chronic Diseases of Motion in the Conducting Apparatus of the Acoustic Organ," Lucae first described an instrument for direct mechanical vibration of the membrana tympani. Lucae's device consisted essentially of a steel sound carrying at its end a hollow cone, which is controlled by a handle composed of a small tube and an adjustable spiral spring. The cup-shaped extremity of the sound is applied to the short process of the malleus, and being manipulated by the hand of the operator, must necessarily be limited as to degree, extent, and number of impulses.

The fact that so simple and crude a mechanical device has led to marked therapeutical results in certain forms of middle-ear disease, as has been certified to by its author and other eminent aurists, sufficiently excuses the writer for presenting the following illustrations and description of an instrument which has proved more than satisfactory in those cases of impaired hearing and tinnitus which are directly traceable to some defect in the conducting apparatus of the ear.

In the first illustration (fig. 1) the instrument is shown in position. As will be seen, the head of the patient is turned slightly toward the opposite side, as for an ordinary examination of the middle ear, and firmly fixed in this position. An ordinary round ear speculum is introduced, and the canal

* New York *Medical Journal*.
† Verhandlungen des 10, Internat. Med. Cong., Berlin, 1890.
‡ Die Heil-Erfolge der inneren Schleimhaut-massage, Graz., 1892.
§ "Internal Massage in Diseases of the Nose and Throat," *Medical Record*, Vol. xlviii., No. 4.
‖ "New Instrument for Vibratory Massage of the Nasal Mucous Membrane," New York *Medical Journal*, Vol. ix., No. 25.
¶ *Archiv für Ohrenheilkunde*, Band xxi., 1884.

illuminated in the usual manner. The speculum is omitted from the illustration, in order to show more clearly the position of the sound as it enters the external auditory canal. The motor, with pressure sound attached, is shown in fig. 2. The right hand grasps the handle of the motor, with the thumb resting on the button of the contact spring. The corrugated handle, B (fig. 3), of the pressure sound, A (fig. 3), is firmly held between the thumb and index finger of the left hand. The tip of the little finger is made to rest gently on the head of the patient immediately behind the auricle, and the sound is introduced parallel to the anterior superior wall of the auditory canal, until the cylindrical extremity of the spiral end, D (fig. 3), rests upon the base of the short process of the malleus. The short process of the malleus is selected as the point of contact, as it has been demonstrated by Lucae,* that "if the malleus is still movable, more or less free movements are seen at once to take place in the whole drum membrane, which, in the majority of cases, correspond to the movements of the short process—*i.e.*, occurring inward on pressure upon the latter, and outward on removal of pressure." Dr. E. B. Dench,† in his recent work on the ear, referring to the same subject, says: "It has been demonstrated that pressure exerted at the short process of the malleus is communicated directly through the incus to the footplate of the stapes, and from this to the labyrinth."

Fig. 1.

When contact is made with the pressure button before referred to, vibrations ranging from 500 to 1,500 or more a minute, judging from the note obtained from the revolutions of the armature, are produced. The extent or length of the vibrations is thoroughly controlled by the eccentric throw, G (fig. 3), and the binding screw, H (fig. 3), the range being from zero to half an inch.

In the cases so far treated, the best results have been obtained by a minimum length or extent of vibrations, and a maximum number of vibrations. It is seldom that the binding screw has been further removed from the centre of the eccentric throw than $\frac{1}{16}$th of an inch, and when this minimum length of stroke has been adhered to, in no case has the patient experienced pain.

In a few instances, where a slight discomfort has been noticed, examination has shown this to be due to undue pressure on the speculum. Eczematous and excoriated canals, of course, must be cured before beginning the massage of the drum membrane.

The duration of treatment varies, the average being from three to ten seconds at each sitting, and should be repeated from two to three times a week.

A few mechanical hints, developed from several months' use of this treatment, may not be unwise at this point before presenting a few histories illustrating its therapeutic value.

The motor and sound should be firmly and steadily held in the same plane (see fig. 1). As the motor and sound are carefully adjusted to run smoothly at right angles, any twisting of the motor will cause an immediate binding of the shaft, E (fig. 3). The pressure sound, A (fig. 3), is made an inch longer than the handle, B (fig. 3), to allow for the length of vibration, and the handle must be held in the centre of the sound.

The cylindrical end of the sound, A (fig. 3), enlarges toward its distal extremity, and in shape resembles more nearly a truncated cone. It is hollowed out, as will be seen by the dotted lines in the cut, not only to better adapt itself to the short process of the malleus, but also to receive a pledget of absorbent cotton or other soft material in order to prevent any possibility of mechanical injury. Sounds with spirals of different strengths have been found necessary, and in every case the writer has found it wiser to begin with the one of least resistance and to continue its use until the patient's confidence has been secured, and a certain degree of tolerance obtained. The motor is adapted to a 2-volt current. Any good storage cell will suffice.

A few brief histories are presented, to show the results obtained. In each case reported, other methods of treatment had been persistently tried without lasting, and, I might say, with no benefit.

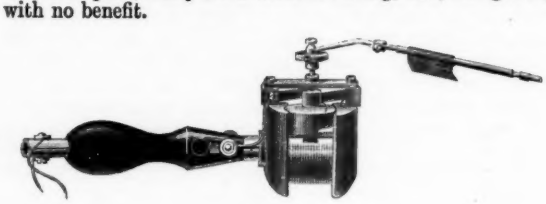


Fig. 2.

Case 1.—Essie L., aged 19 years; occupation, dressmaker. Came to St. Bartholomew's clinic for treatment on December 4th, 1894. Complained of deafness and constant ringing in both ears. The following history was obtained:—Deafness and tinnitus in both ears for three years; unable to state in which ear symptoms began first; has had treatment for nine months, with the result of a slight improvement in hearing, but no relief from the tinnitus; never had pain or discharge from either ear; no assignable cause; no heredity.

Examination.—Auricles and canals normal; both *membranæ tympani* uniformly cloudy and moderately retracted, but not funnel-shaped; light reflex lost; short process not unduly prominent; little or no fibrous tissue; membrane moved throughout by Siegel's otoscope; handle of malleus slightly foreshortened; Eustachian tubes patulous; watch heard on contact only: bone conduction markedly increased; lower tone limit elevated; chronic catarrhal inflammation of the naso-pharynx.

This case will be readily recognised as one of chronic catarrhal otitis media.

Treatment consisted of ordinary cleansing and care of naso-pharynx and direct massage of the ossicular chain three

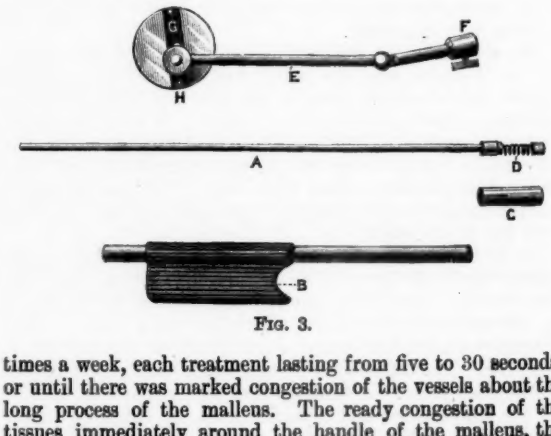


Fig. 3.

times a week, each treatment lasting from five to 30 seconds, or until there was marked congestion of the vessels about the long process of the malleus. The ready congestion of the tissues immediately around the handle of the malleus, the writer believes, has much to do with the prognosis in a given case. After the third massage, the tinnitus, which had been greatly diminished in intensity by the previous treatments, ceased, and the hearing distance increased to an inch.

* *Archiv für Ohrenheilkunde*, Vol. xxi., p. 84.
† Dench. "Diseases of the Ear," p. 382.

January 14th, 1895, date of last visit, hearing distance had increased to 4 inches ($\frac{4}{25}$) and tinnitus had not returned.

Case 2.—Allied to case 1, but of longer duration, is that of C. F. M., aged 40 years; occupation, physician. Right ear chiefly involved; tinnitus and impaired hearing for five or more years; no pain; no discharge; no hereditary tendency. Auricle was found to be normal; slight squamous eczema of canal; drum membrane dull; no light reflex; scar tissue marked; movement of drum and malleus limited; short process prominent and long process foreshortened; ossicles firmly bound together, and mucous membrane apparently thickened; Eustachian tube open, but not freely so; slight mucous rhonchi; watch heard on close contact; chronic hypertrophic naso-pharyngitis and pharyngeal tonsils filled with leptothrix masses.

Treatment began March, 1894. Politzerisation; use of Delstanche masseur; applications to the naso-pharynx, and squeezing out of the masses from the tonsils resulted in a decided improvement of the general condition, but no corresponding improvement in the symptoms most complained of.

Treatment was discontinued during the summer, to be resumed early in December; conditions the same as before treatment, with the exception of the naso-pharynx. Direct massage was immediately begun on patient's return, and treatment of naso-pharynx continued. The lessening of the tinnitus began with the first massage, and, at present writing, March, 1895, hearing distance for affected ear is 2 inches ($\frac{2}{25}$), and tinnitus can only be heard occasionally at night with the head resting on a pillow.

Case 3.—A. M., aged 29 years; began treatment February 4th, 1895. Complained of loss of hearing and tinnitus in both ears; more pronounced in right ear; duration, four years; has had an occasional furunculosis of both canals. Examination revealed a case of chronic catarrh of the middle ear. Watch heard on contact, A. D., and at an inch ($\frac{1}{25}$), A. S.

Patient has had massage of drum membrane twice a week regularly.

On March 14th, date of last record, watch was heard by A. S. 7 inches ($\frac{7}{25}$), A. D. 2 inches ($\frac{2}{25}$). Entirely free from tinnitus.

From the cases herewith reported, and from a large number now under treatment, both in private practice and at the clinic, the writer feels justified in the following conclusions:—

That in the mechanical mobilisation of the ossicles by vibratory massage we have an agent of undoubted value in chronic and subacute affections of the middle ear. That the therapeutic value of this method depends largely on the rapidity and amplitude of the vibrations.

That it is a safe method of treatment in all cases of impaired function due to some defect in the conducting apparatus. That it is of especial value in sclerosis and in atropic conditions by virtue of its action in increasing the vascularity, and hence the nutrition of the part.

That in hypertropic otitis media this method is safer, and to be preferred to the pneumatic method of Delstanche, which is unsafe, and in many cases positively harmful.

That it is a method easy of application, causes little or no reaction, and is unattended with pain or discomfort to the patient.

Since writing the above, we have been especially fortunate in having obtained and read an article by so eminent an authority as Dr. P. Garnault,* who has devised and used an electric pressure sound similar in construction to the one described above.

In addition to massage through the external auditory canal, Dr. Garnault has employed rapid (600 to 700 per minute) vibrations through the Eustachian tube to the drum membrane, which he believes to be especially useful in certain labyrinthine diseases.

Garnault's results have been corroborative of those published by Lucae. The value of rapid and mechanically accurate vibration is particularly emphasised by this writer.

Since the publication of this article, the writer has devised a sound for the vibration of the throat and nose in atropic catarrh. The sound is adapted to the same motor and connecting rod as the pressure sound for the ear.

ELECTRO-DEPOSITION OF BRASS.†

By FRANK SUTTON, E.E.

(*Concluded from page* 334.)

The results obtained are given in Tables III. and IV. and in figs. 4 and 5. The deposits were about the same, but not quite so good.

The specific resistance was 12 ohms, which is 2 ohms higher than the pure cyanide solution.

Table III.

Solution cyanide Zn Cu + lot of salts of Na. Regular brass solution. Platinum cathode, brass anode. Size of plate and distance between, same as in Table II.

	E.M.F.	B.E.M.F. reading.	B.E.M.F. $c = \frac{E-e}{R}$	Current.	$E-e$.	$E-e$ formulæ.	Cu per cent.	Zn per cent.	Temp.	Colour.
1	·1	...	...	...	...	...	...	...	27°	...
2	·15	...	...	...	...	...	...	...	"	...
3	·25	·2	·2	·007	·05	·05	100	0	"	Copper.
4	·50	·35	·3	·026	·15	·20	70	30	"	Good brass.
5	2·2	1·5	1·6	·08	·7	·6	63	37	"	"
6	4·3	2·	2·	·3	2·3	2·3	52	48	"	White brass.
7	6·	...	...	...	...	...	...	...	"	Commenced to get uneven.

From these results it seems that the purer we have the solution, the better are the results.

In the case of the pure cyanide solution the deposits were better than those of the other solution, and the resistance was lower. It will also be seen that the composition of the

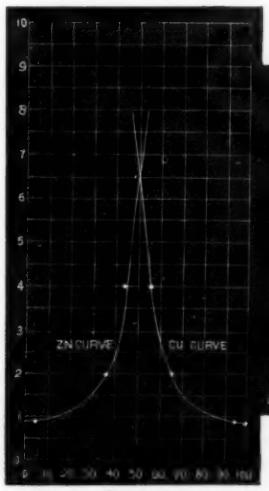


Fig. 5.—Percentage of Zinc and Copper.

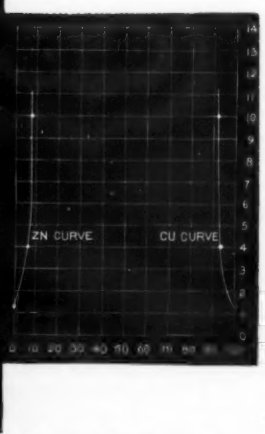


Fig. 6.—Percentage of Zinc and Copper.

* La Massage vibratoire et électrique dans les affections de la gorge, des oreilles et du nez. Société d' editeurs scientifiques, Paris, 1894.

† *Electric Power*, New York.

anode and cathode affect the amount of current that is passed through it, and one must be chosen that has a low resistance. The substance that the deposit is made upon is not limited to platinum and carbon, but we can deposit on any metal as long as it is clean and free from grease. In the course of these experiments several different cathodes were used to deposit the brass on such as iron, lead, tin, zinc and copper, and also a piece of wood well covered with graphite, and it was found they all worked very well.

IV. The Actual Voltage that Does the Depositing.

In the table it will be noticed that in the first column is given the E.M.F. as measured across the terminals of the electrodes, No. 2 is the counter E.M.F. as read from the voltmeter in the manner explained, No. 3 is the counter E.M.F. as worked out by the formula,

$$C = \frac{E - e}{R}, \qquad (4)$$

where C = the current,
E = the impressed E.M.F.,
e = the counter E.M.F.,
R = resistance of solution.

Resume.

In summing up the results obtained in the case of a copper and zinc solution, the following statements may be made :

1. The alloy deposited depends upon the impressed electromotive force.
2. As the impressed E.M.F. is increased the alloy will change its proportions, these proportions depending on the velocities of migration of ions in the different salts.
3. The amount of zinc increases directly with the impressed E.M.F. and finally reaches a point where more of it is deposited than of the copper.
4. The best alloys are obtained when the impressed E.M.F. exceeds the counter E.M.F. by a small amount.
5. As the impressed E.M.F. is increased the C.E.M.F. will increase, but at a much reduced rate, and this rate decreases so much that when the impressed is very high, the counter is negligible.

Now this counter E.M.F., although it does cause a certain amount of energy to be lost, may be considered a help as far as electroplating work is concerned as it really throttles the current and keeps the ions from combining too rapidly.

This course of experiments was carried on in the electrical engineering department of Columbia College.

Table IV.

Same as No. 3, only platinum anode.

	E.M.F.	B.E.M.F. reading.	B.E.M.F. formulæ.	Current.	$E - e$.	$E - e$ formulæ.	Cu.	Zn.	Temp.	Colour.
1	·25	...	...	...	...	...	...	...	27°	
2	·50	...	...	...	...	...	...	...	"	
3	·90	·84	·85	·007	·06	·05	95	5	"	Copper.
4	2·0	1·65	1 6	·06	·35	·40	64	36	"	Good brass.
5	4·0	2·03	2 0	·25	1·97	2·00	56	44	"	White brass.
6	10·	...	...	...	...	...	...	...	"	
7	18·	...	...	...	...	...	...	...	"	Uneven.

Table V.

Saturated solution of Cu So_4 and Zn So_4. Electrodes the same as preceding cases.

	E.M.F.	B.E.M.F. reading.	B.E.M.F. formulæ.	Current.	$E - e$.	$E - e$ formulæ.	Cu.	Zn.	Temp.	Colour.
1	·5	...	...	...	...	...	...	...	27°	...
2	1·	...	...	...	...	...	trace	...	"	...
3	1 35	1 21	1·2	·01	·14	·15	100	0	"	Copper.
4	4 11	1·5	1·5	·25	3·61	3·61	94	6	"	...
5	10·	2 0	2·0	·73	8·	8·	92	8	"	...

The form in which we can apply the formula is best as follows :

$$e = -RC + E. \qquad (5)$$

In No. 4 is given the current. In No. 5 is the difference between the impressed and counter E.M.F. as read from the voltmeter, and in No. 6 is the difference as worked out from column No. 3, or from

$E - e$ = the voltage that did the work.

It is evident from the first part of the paper that only a fraction of the impressed E.M.F. was used to do the depositing. The other part not only overcoming ohmic resistance which was a small factor, but the counter E.M.F. which was a very large one, and this relation can be expressed by $E - e$, which, as will be seen, is very nearly so. Perhaps an illustration to show the correctness of the formulæ will be well. Take, for example, No. 3 in Table I.

Voltmeter reading was ·25 ; ammeter reading ·058 nearly, and the counter E.M.F. was ·18, applying formula 5.

$$e = -1{\cdot}2 \times {\cdot}051 + {\cdot}25 = {\cdot}188.$$

From this we see that it tallies very well with the reading applying Ohm's law :

$$C = \frac{E}{R} = \frac{{\cdot}25 - {\cdot}188}{1{\cdot}2} = \frac{{\cdot}062}{1{\cdot}2} = {\cdot}051 \text{ ampère.}$$

ANOTHER REMEDY FOR ELECTROLYTIC CORROSION FROM STREET RAILWAYS.

By JOHN GRAY, B.Sc.

The prevention of injury to gas and water pipes and telephone cables, by the leakage from electric railways, has already become a question of the first importance in the United States, and will probably soon become equally, if not more, pressing here. America has more than 100 miles of electrical street railways for every mile in Great Britain, and though vested interests are not so strictly protected by law in the United States as here, still electric railway engineers begin to realise that some plan is necessary to remedy the evil.

In the single trolley system, which seems to be the only system financially possible, the current flows from the car wheels to the rails, and by these it must find its way back to the dynamos. The rails are usually bonded together to make them continuous conductors ; but notwithstanding this, being uninsulated, they carry only part of the current, the earth and any metallic conductors, such as pipes and armoured cables in the neighbourhood of the track, taking the rest. As is well known, these leakage currents accelerate the

natural rate of corrosion, where they leave the underground conductors in the neighbourhood of the power house.

Various plans have been proposed by American engineers to remedy the evil. The section of the pipes in danger has been bonded by wires to the rails, but this in some respects increases the evil by increasing the current in the pipes. A better plan, proposed by Harold P. Brown, consists in keeping the pipes always slightly negative to the rails, and thus preventing the corrosive outflow of current. This plan, though a great improvement, still leaves considerable current in the pipes, which will give rise to corrosion at highly resisting joints by the action of the shunt currents.

In the August number of *Cassier's Magazine* a plan is described by Mr. Isaiah H. Farnham, which appears to be a considerable advance on previous proposals. He makes the principle of the plan very clear by the help of a hydraulic analogy. The rails through which the current is flowing back to the dynamo house may be compared to a channel through which water is flowing towards a point where a pump is connected, and continually pumping the water out of the channel. The level or head of the water at the points most distant from the pump will, of course, be considerably higher than in the neighbourhood of the pump, and this difference of level may cause the water to overflow the banks of a level channel and escape into the ground at the most distant points. This is exactly analogous to what occurs in the uninsulated rails of an electric railway when the return current is flowing through them. It is the difference of potential between the home and distant ends of the rails which is the cause of the objectionable leakage. If this difference of potential could in any way be got rid of, the evil would be overcome.

Mr. Farnham explains his plan for effecting this by a further application of his hydraulic analogy.

In fig. 1 the water channel, A, A, represents the rails carrying the return current. The bottom of the channel communicates with a pipe running parallel to it by numerous short connecting pipes. This pipe is connected to the pump which represents the dynamo. Now, it can be seen that if there is the same resistance in each branch pipe leading from a point in the channel to the pump, the same amount of water will be pumped out of the channel at each point, and the water in the channel will remain approximately at the same level if the flow into the channel is uniform at all points.

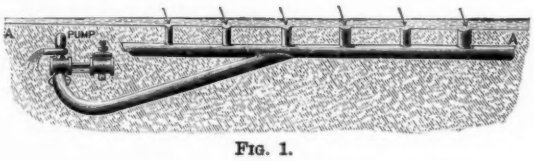


Fig. 1.

As may be anticipated from this illustration, Mr. Farnham's method "consists in extending from the negative or rail side of the dynamo an insulated return wire, either on poles or underground, throughout the entire length of the railway, including all cross-town or branch tracks. This return wire is to be of such size as to properly carry the current, and to maintain the return path at a comparatively low resistance. For a track extending three miles in one direction from the power house a No. 0000 copper wire would give a resistance of but 1 ohm from the most distant point. Two such wires about ⅓rd inch in diameter each would not seem excessive in cost, and would render the maximum resistance but ½ ohm from car to power house. In large railway systems a still heavier main return may be employed. From this general wire or system of wires frequent connections would be extended to the track system, say one at every other pole (200 feet). Let these connections between the general return wire and the rails be of such size, or shape, as to cause the resistance from the rail at the nearest point to the power house to be the same, no more, no less, than from the most distant rail connection to the power house; that is, with such a system, if the resistance of the circuit from the rail, three miles distant to the power house is ½ ohm, the resistance from any other point along the route of the track shall also be ½ ohm to the power house. Allow no ground connection on the dynamos, and no direct connection to the rails without the proper resistance." This system is roughly represented in fig. 2. If there is a uniform distribution of cars there can be no rise or fall of potential except in the sections between points of attachment of the return wires. This equi-potential system, just described, has been so far tried in a New England city as to indicate practically that the benefits claimed for it may be confidently expected.

Speaking of this method of his, Mr. Farnham says: "No description of this plan has ever before appeared in print." This shows that Mr. Farnham is not a careful reader of the Electrical Review, where, at p. 772, June 21st, 1895, he will find a plan described which differs from his own only in some points of detail. The paragraph in question says: "It appears to us that more might be done without great extra cost to diminish the flow from the track to the pipes. The object to be aimed at is to reduce the track as near as possible to zero potential throughout, and theoretically this can be effected by connecting each short section of the track to

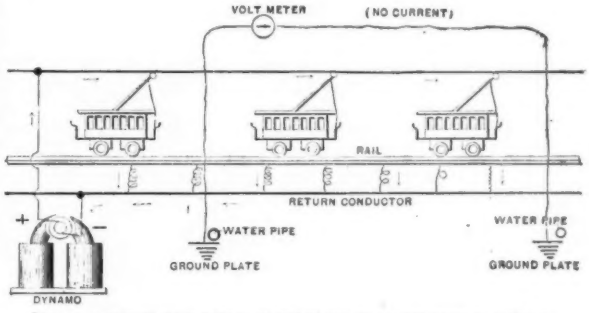


Fig. 2.—A system with which electrolysis of buried pipes is avoided.

Fig. 2.

the negative pole of a generator, at the necessary number of volts below zero potential, by an insulated conductor of such resistance as will just draw off the quantity of electricity discharged into the section by the passing cars." This undoubtedly is the plan which Mr. Farnham claims.

His method of carrying it out is a long way from realising the theoretical requirements of this system. A much better approximation to these requirements would be attained by running a separate insulated wire from each section direct to the dynamo. The resistance of any one of these wires could then be varied in the power house when it was found that any section of the line was deviating to a dangerous extent from zero potential. These return wires might be air lines running across town direct to the power house. These wires could also be used as a means of measuring the potential of the section to which they were connected and actuating an automatic resistance regulator.

Such a system as this, if carried too far, might prove more costly than an insulated conductor in a conduit, but even if it cost as much, the cost of maintenance would probably be much less. But whatever the cost may be, the problem of preventing dangerous leakage in electric street railways will have to be solved, or the business will have to be given up.

NEW PATENTS—1895.

17,232. "An automatic and electrical tell-tale apparatus for indicating water and other liquid levels." J. Dixon. Dated September 16th.

17,249. "An improved gauge for gauging electrical and other wires, drills, boring bits, and other similar articles." A. E. Woodhouse. Dated September 16th. (*Complete.*)

17,269. "Improvements in dry cells." C. E. C. Jungnickel. Dated September 16th.

17,283. "A method or system of utilising town's water for generating electricity." E. Booth. Dated September 17th.

17,287. "Improvements in and relating to insulators for telegraph and telephone poles." W. Dibb and A. Vickers. Dated September 17th. (*Complete.*)

17,288. "Improvements in and connected with the electrolytic decomposition of alkaline salts." W. A. Rosenbaum. Dated September 17th. (*Complete.*)

17,290. "An adjustable support for electric lamps or similar fixtures." G. Davies. (Communicated by O. C. White, United States.) Dated September 17th. (*Complete.*)

17,328. "Improvements in electrical attachments for playing pianos." G. H. Davis. Dated September 17th. (*Complete.*)

17,330. "Improvements in electric exploders." H. V. Keeson. Dated September 17th.

17,365. "Improvements in and relating to auto-mobile cars for electric railways." R. Belfield. Dated September 17th.

17,400. "Improvements relating to permanent way, electric conduits, and conductors of electric tramways." J. T. Wood and J. A. Brodie. Dated September 18th.

17,430. "Improved methods of and means for making and breaking electric circuits" R. Belfield. Dated September 18th.

17,436. "Improvements in thermo-electrical generators and the method of operating same." H. B. Cox. Dated September 18th. (*Complete.*)

17,442. "Improvements in electric resistances." L. B. Stevens. Dated September 18th. (*Complete.*)

17,479. "An improvement in connection with electric pushes for hall or other doors which may be used in connection with or replace existing door knobs, handles, or pushes." C. P. J. Fitzsimon. Dated September 19th.

17,481. "Improvements in electroliers." R. H. Best. Dated September 19th.

17,495. "Electrical heating apparatus." V. I. Feeny. (Communicated by H. W. Johns Manufacturing Company, United States.) Dated September 19th. (*Complete.*)

17,505. "Improvements in electrodes." C. Hoeffner. Dated September 19th.

17,507. "Improvements in and relating to electric cables." J. Graizier. Dated September 19th.

17,510. "Improvements in electric current meters." R. Hacking and G. Brand. Dated September 19th.

17,514. "Improvements in incandescent lamps, operating by the vaporisation and combustion of volatile fuel." W. Quaadt. Dated September 19th.

17,525. "Improvements in the electrolytical manufacture of bleaching liquid." C. Kellner. Dated September 19th.

17,526. "Improvements in electrical transformers." A. F. Berry. Dated September 19th.

17,528. "A new and improved electro-deposition, more especially applicable to electroplating." A. F. B. Gomess. Dated September 19th.

17,529. "Improvements in arc lamps and in stands therefor." B. J. B. Mills. (Communicated by E. P. Hopkins, United States.) Dated September 19th.

17,573. "Improvements in electrolysis." G. Poore. Dated September 20th.

17,603. "Improvements in electric batteries." M. M. Bair. Dated September 20th. (*Complete.*)

17,631. "Improvements in microphones." L. M. Guyomard. Dated September 21st.

17,634. "Improvements in and relating to incandescent electric lamps." W. H. Soulby. Dated September 21st.

17,655. "Improvements in secondary batteries." B. M. Drake and J. M. Gorham. Dated September 21st.

17,656. "Improvements in spring contact switches." B M. Drake and J. M. Gorham. Dated September 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1895.

2,289. "Apparatus for counting or recording telephonic conversations." J. E. Kingsbury. (A communication from abroad by the Western Electric Company of Chicago.) Dated February 1st. This invention relates to apparatus for counting or recording telephonic conversations, its object being to register each use of a subscriber's telephone line in which the subscriber is actually placed in position to communicate with the party called for. 11 claims.

2,915. "Improvements in systems of distribution by alternating currents." J. Devonshire. (A communication from abroad by C. P. Steinmetz, of Schenectady.) Dated February 9th. Comprises a monocyclic system of distribution, and consists of certain improvements whereby lamps or other single-phase translating devices, as well as multiphase motors, may be supplied with current from a single source of power and a common system of circuits. The end is attained through the agency of a supplementary or phase-modifying source of electromotive force so arranged as to act jointly with the main source of electromotive force but having a different phase relation, so that by the combined action of the main and supplementary sources an electromotive force of displaced phase is maintained upon the third or intermediate main of the polyphase circuit. 13 claims.

3,178. "Improvements in and connected with testing and junction boxes, manholes, and culverts for electric light mains and other purposes, and in covers therefor." W. Macpherson. Dated February 13th. The object of this invention is to provide an efficient method of ventilating electric testing and junction boxes, manholes, culverts and the like, so as to allow of the escape of any gas which may leak into or be generated in the box or other receptacle, and also to prevent any condensed moisture or surface water from accumulating therein. 6 claims.

3,250. "Improvements in globes for electric glow lamps." V. de Spruner-Mertz and J. Koch. Dated February 14th. The globe is made with its lower part transparent, and with its upper part rendered reflective by silvering or otherwise. 2 claims.

3,573. "Improvements in telephonic apparatus." N. L. Burchell. Dated February 19th. Has for its object to provide a telephone of any ordinary type with means of supporting the transmitter and receiver so that they can be adjusted to suit persons of different height and to allow the receiver to be applied to either ear. 11 claims.

4,497. "Improvements in electro-magnetic apparatus for operating indicators, valves, and other devices." O. von Morstein. Dated March 2nd. Has for object to obtain a regular alternating action of two electrc-magnets with only one conductor and one contact common to both magnets, in such a way that the apparatus shall always place automatically in the circuit that electro-magnet the action of which is required upon the next contact or circuit closure. 2 claims.

4,576. "Improvements in electric motors." A. H. Brintnell. Dated March 4th. Consists essentially of a serial of double field magnets held in a circular non-magnetic frame supported on suitable standards and having the inner ends of the poles of the magnets flush with the inner circle of the frame and a number of spool armatures journalled free to rotate in bearings in supporting discs secured to the main shaft of the motor and in direct successive contact with the poles of the magnets, a commutator of peculiar construction being provided to throw the current into both magnets and spool armatures, so as to cause a pull upon the spool armatures in succession and rotate the shaft. 4 claims.

5,700. "Improvements in electric arc lamps." G. R. MacIntire. Dated March 19th. The lamp is so arranged that no parts of the structure shall interfere with the laterally or downwardly directed rays of light, this lamp being adapted to be supported from above. 5 claims.

5,998. "An improved cup and ball joint for electrically connecting and disconnecting electric light fittings." R. W. Braham. Dated March 22nd. Relates to an improved cup and ball joint whereby electric light fittings may be easily detached from the main wires without the necessity of unwiring, which is the case with the arrangements now in use. 2 claims.

6,249. "Improvements in or relating to aerial electric railway or transportation systems." A. J. Boult. (A communication from J. W. Kilmore, of Chicago.) Dated March 26th. The object of the invention is to improve the postal service by providing means for quickly transporting the mails by electricity to and fro between the main station and sub-stations. 4 claims.

6,893. "Improvements in electrical signalling apparatus for marine purposes." H. H. Lake. (Communicated from abroad by B. A. Fiske, of New York.) Dated April 3rd. Relates to an apparatus whereby from a given station an order may be sent to a distant point, and whereby, through the mechanical execution of said order, a knowledge that the same has been obeyed will be transmitted back to the main station.

7,041. "A protecting cover for telegraph posts." J. Wohl. Dated April 5th. Consists in enclosing the portion of the pole a little above and below the ground line by a guard or sleeve of glazed stoneware constructed in two separable parts or semicylindrical halves to enable it to be put in place. After placing them round the post the two parts are brought together to constitute the sleeve, and are retained and united by means of four pieces of galvanised steel wire, passed through small holes provided on each side a few centimetres from the extremities and carefully tightened with pincers. The annular space which exists between the post and the interior periphery of the sleeve is then filled with a drying substance indicated by experience, mixed with proportionate parts of silicious sand, small gravel and water in order to compose a cement which completely adheres to the post and to the sleeve, and which as it dries acquires the hardness of granite. 1 claim.

7,142. "Improvements in regulating transformers for alternating currents." Manchester Edison-Swan Company, Limited, A. Still, and E. W. Cowan. Dated April 8th. The object of the invention is to obtain in an improved manner a transformer which will give a variable ratio of transformation of electromotive force, the ratio being altered by a mechanical movement of a part of the apparatus either by hand or automatically. 3 claims.

7,245. "Improvements in electric railways." J. H. Guest. April 9th. Relates to electric railways wherein the working conductor from which the car takes up current is divided into sections which are insulated from one another and from the source of power current, and are provided with automatic switches that are actuated to close the connection with the source as the car enters a section and open it when the car leaves the section. 13 claims.

7,657. "Improvements in secondary or storage batteries." W. M. McDougall, H. B. Adams, and G. P. Smith. Dated April 16th. One of the principal objects of the invention is to provide a means whereby a number of electrodes may be assembled in a battery, spaced apart, and free access of the liquid solution permitted to them. Further objects of invention are to prevent the detaching of the active material from the electrode and to provide a battery of long life and of great efficiency. 9 claims.

7,795. "Improved construction of electrical accumulators." Vicomte G. de Schrynmakers de Dormael. Dated April 18th. Relates to an improved construction of electrical accumulators based on the principle that the oxides in general and in particular the peroxide of lead, used in accumulators, have no specific conductivity, and that, if they conduct the current when in action, it is only due to the interposed liquid in which they are immersed. 2 claims.